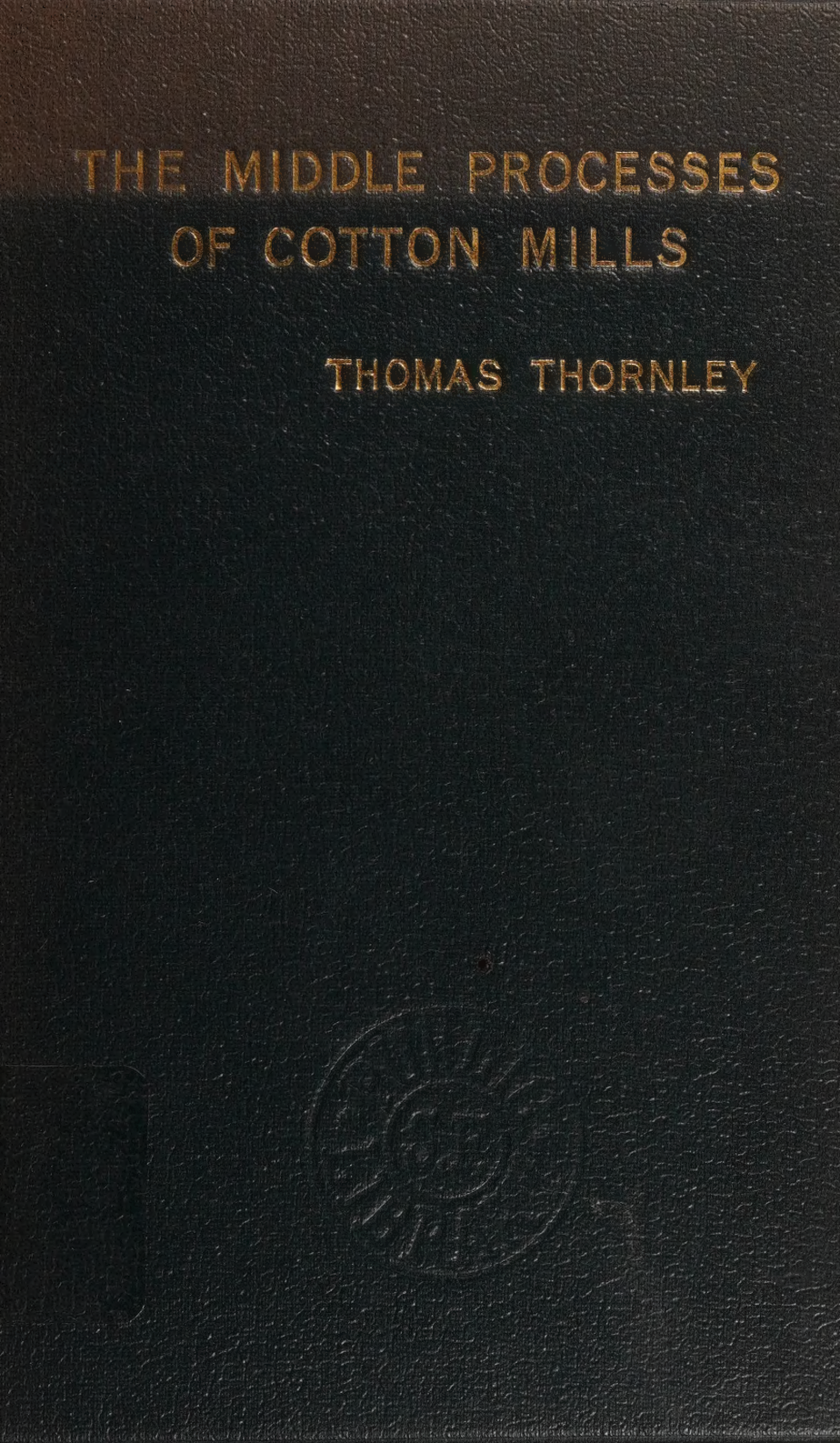
THE MIDDLE PROCESSES OF COTTON MILLS

THOMAS THORNLEY



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THE MIDDLE PROCESSES OF COTTON MILLS

BY

THOMAS THORNLEY

HEAD OF TEXTILE DEPARTMENT, TECHNICAL SCHOOLS, BOLTON; AUTHOR OF "ELEMENTARY COTTON SPINNING," "INTERMEDIATE COTTON SPINNING," "ADVANCED COTTON SPINNING," "MODERN COTTON ECONOMICS," "COTTON WASTE," AND OTHER TREATISES FOR THE COTTON TRADE

WITH NINETY-TWO ILLUSTRATIONS

LONDON
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PREFACE.

It was at first intended that the subject-matter of this treatise should be included in one large volume with the Author's new work on Advanced Cotton Spinning.

It soon became evident, however, that such a one-volume treatise would be altogether too large and cumbersome to suit modern requirements.

Moreover, some of these middle processes, and the Doubling Trade generally, are often carried on by individuals and firms having nothing to do with actual spinning of yarn and not desirous of purchasing the larger volume. This treatise forms a compendious one-volume exposition of processes subsequent to spinning, but preceding actual weaving. It is suitable for any person seeking information on this section of industry or for individuals actually engaged in some one branch of the processes described. Also for persons engaged in the Doubling Trade.

The result of fifty years' personal contact and investigation of the processes and machinery described are embodied in the descriptive matter.

The Author on very many occasions has been asked for a compendious one-volume treatise upon these Middle Processes and on the Doubling Trade generally. It is hoped and believed that such want will now be supplied.

Subjects and machinery dealt with include Reeling, Bundling, many kinds of Winding Frame, Warping, Sizing, Polishing, Gassing, Preparing, Doubling and Twisting on various machines; the production of "Fancy" or "Novelty" Yarns. Also Packing, Conditioning, and Transport of Yarns. Some Calculations are included, but there is practically nothing of the question and answer style of treatment.

This book is designed to form one of the Author's series,

which includes "Elementary Cotton Spinning," "Intermediate Cotton Spinning," "Middle Processes of Mills," "Modern Cotton Economics," and "Advanced Cotton Spinning." The Author's books on Mule Spinning, Cotton Combers, Cotton Waste, etc., are intended more for specialists.

The thanks of the Publishers and Author are due to firms or individuals who have helped with the illustrations or descriptive matter and whose names are given in the context.

The character and scope of the machinery and processes described in the following pages make the book more or less suitable for either Spinning, Weaving, or Doubling people; and these not necessarily confined to the Cotton Trade alone since much of the information applies to other Textiles.

THOMAS THORNLEY.

Bolton, *August*, 1923.

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CHAPTER I.

REELING, MAKING UP, BUNDLING.

YARN is reeled and bundled very largely for export purposes. In this way much yarn both from mules and ring-frames is prepared for export. Particularly in the case of ring yarn spun upon spools or bobbins is this system advantageous. Instead of being at the expense of paying for the weight of the bobbins during transit, it is obviously a great advantage to reel and bundle the yarn. Reeling and bundling processes are of the simplest character, and the first cost in the machines is not large. In reeling for bundling and shipping purposes it is usual to wind a hank of 840 yards upon the reel from each cop or bobbin, and to have the hank disposed upon he reel in parallel layers divided into seven parts, each division containing a lea or 120 yards. The reel is 54 inches (usually) or $1\frac{1}{2}$ yards in circumference. The hanks being reeled, they are made up into bundles of 5 lb. or 10 lb. each, and are compressed into a solid compass in the bundling press. In this form the cost of transit is small, and the yarn when arrived at its destination can readily be wound upon bobbins and utilised for weaving purposes if required. Also dealt out in small lots. Reeling and bundling are done for both single and doubled yarns.

Cross reeling is carried out when it is intended to dye, prepare, or bleach the yarn. In this form the yarn is left in a somewhat open condition, and, therefore, can take dye better, and is at the same time more easily unwound without entanglement. Cross winding is obtained by a swift backwards and forwards movement being imparted to the thread guide rail by a crank or eccentric. Cross reeling is most used for the home trade, and open reeling for the foreign trade.

The Figs. 1 and 2 are intended to illustrate the more important details about ordinary reels. Fig. 1 shows the arrangement for open or 7-lea reeling, there being two portions of hanks of yarn shown on the reel staves, C. O, P are the pulleys by which the machine is driven. At A is a worm on the reel shaft which rotates the 80-worm wheel, E. F is a finger carried by the worm wheel, and, when the latter has made one revolution, F lifts stepped rack ladder shown up one tooth. The spring, S, always keeps the

guide bar stud at M pressing against the stepped ladder, G. When the latter is lifted by the stud, F, the guide bar is moved lengthways

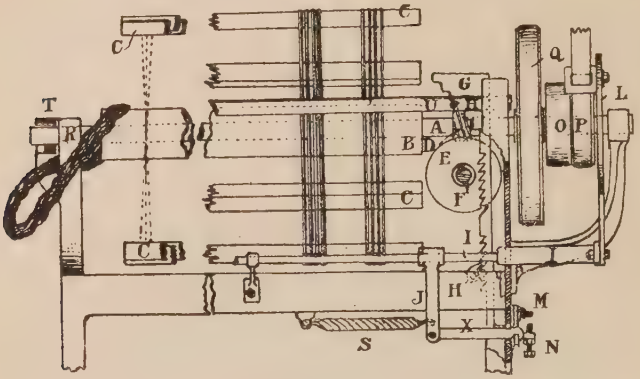

FIG. 1.

against the next lower rung of the stepped rack, G, thus causing the yarn to be laid in a different position on the reel. On the left is

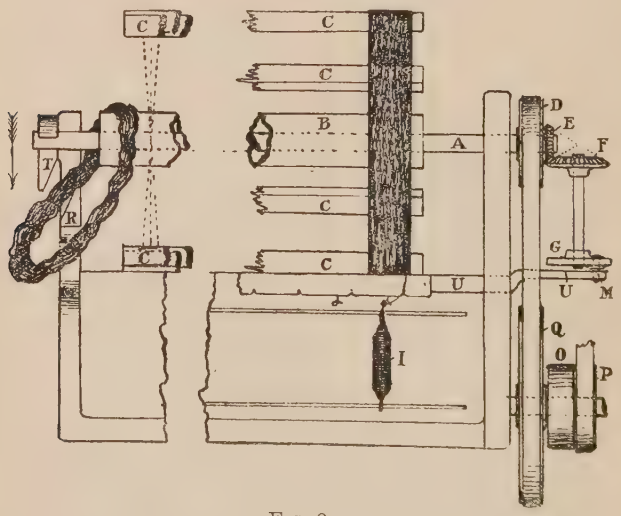

FIG. 2.

shown the reel, C, closed for doffing, with the yarn just being taken off the reel end.

Fig. 2 shows the arrangement for cross reeling. In this case the spring, S, the 80-worm wheel, E, and the stepped rack, G, are not used in the sense explained above, but wheel, E, and rack, G, may be used for stop-motion purposes.

In their place the small bevel, E, is driven by the belt, D, and gives motion to the bevel, F. On the other end of same cross shaft is the crank or disc, G, carrying the stud, M, which in its rotation gives a continuous oscillatory motion to the guide rail, V. In this way the threads are crossed over each other instead of being laid parallel as in open reeling.

A is the reel shaft, B is the reel shell, and O, P the driving pulleys. In this case also the yarn is shown almost doffed at the left-hand portion of the sketch. By a push across the rests, T, R, in the direction indicated by the arrow, the threads will be freed ready for taking off.

Seven-lea, 6-lea, and Double Crossed Hank.

Reeling is mostly "open" or else "crossed." Another common name for "open" reeling is 7-lea reeling, and in this case after a lea of 120 yards has been wound on the reel from each cop or bobbin the traverse bar or guide bar is moved longitudinally, so as to place the second lea a slight distance from the first, and so on with the seven leas that form the hank. The spaces permit the tieing up to be done, so that each lea is kept separate. Six-lea reeling is not very common, and means that six leas are taken as forming the hank instead of the usual seven leas.

Open reeling is common when the process is done for bundling purposes, or as a convenience for transit and other purposes, and is the method almost always employed with yarns for the Eastern markets.

In cross reeling instead of a hank of yarn being wound into seven more or less separate leas, the traverse bar is moved backwards and forwards continuously so as to wind all the hank with the eighty threads crossed over one another.

In the case of double crossed hanks, there are two hanks reeled together in this manner before doffing.

Cross reeling is generally done when the yarn is intended for bleaching and dyeing purposes, as it allows the dye stuff to get to the threads better and more uniformly than "open" reeling.

In addition it may facilitate the finding of broken threads and prevent thread entanglement.

In most reels it is a very easy matter to change from the one kind of reeling to the other.

Often the reeled yarns are made into long bundles, without being

pressed, while other reeled hanks are usually made into short bundles and subjected to heavy pressure in a powerful bundling press.

Doffing.

When doffing the hanks from a reel it was formerly a common practice for the reeler to lift the reel with one hand, while with the other hand the hanks of yarn were drawn off the reel.

Doffing is of frequent recurrence on a reel, and—especially in the case of coarse counts—the weight of a full reel is considerable, so that the strain becomes great for the women and girl reelers. In removing the hanks also it is requisite to take them very close to the oiled end bearing of the reel shaft, and in this way much yarn at times has been marked with dirty oil.

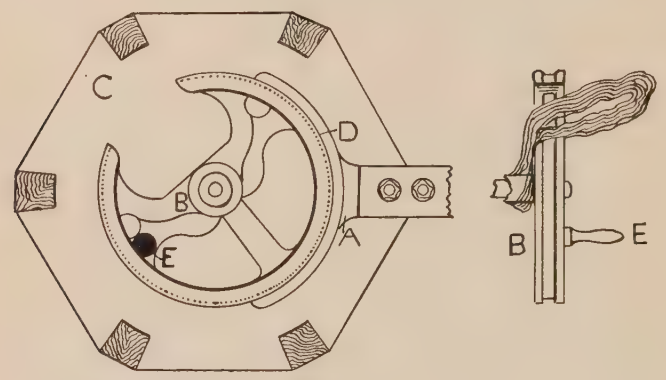

Fig. 3.

Great assistance is rendered in the removal of the hanks by means of "collapsing" motions, by which the reel is closed up so as to loosen the hanks, or else one or two staves are dropped down.

In doffing motions are several makes, the main object of each one being to obviate the necessity for the reeler having to lift the reel up.

There are the "gate," the "wheel," the "bridge," and the "parallel," or "inside" and "outside" motions.

In the "gate" motion the reel end is sustained in a bearing formed in a kind of gate working on hinges, and the gate is opened for doffing purposes, thus leaving a free passage for the yarn. This motion is very effective, but is clumsy, partly due to the necessity for having a support for the reel, arranged so that it is out of the way when working, but supports the reel when the gate bearing is removed for doffing.

Fig. 3 shows the wheel doffing motion. A, D is the rest for the wheel, B ; C is the reel ; E is the handle. A hank of yarn is shown almost doffed. In practice the wheel rest A, D is vertical.

In the "wheel" motion the end of the reel is sustained in a "doffing wheel," which consists of a wheel with a segment absent, that is to say, a kind of broken wheel. The hanks having been drawn to the reel end are passed into the "open" portions of the wheel, and, by giving a slight turn to the wheel, the hanks are freed from the reel end. The "wheel" motion is largely used in some districts, and the "bridge" in other districts.

Fig. 4 is a sketch of the "bridge" motion, with a hank of yarn ready for removal.

Reel Doffing Motions (Figs. 3 and 4).

Fig. 4 at ABC, shows the three positions adopted by the bridge bracket of the bridge doffing motion, when moved from reeling to doffing position, in order to fully release the hanks of yarn.

Fig. 3 illustrates the wheel doffer.

The "bridge" motion is a well-known doffing motion. A gap is formed in the end of the frame, and a slotted bracket termed the "bridge" is used in order to reach across this gap. The bridge during working rests on one end, and during doffing on the other end, while during the horizontal crossing of the reel end it is momentarily horizontal, so as to bridge the gap. A moderate push against the reel is sufficient to force the bridge into any position, and at all times the bridge is supporting the end of the reel. The hanks are partially doffed, and then the reel is pushed smartly across the bridge, thus freeing the other side of the hanks and allowing of their ready removal. The bearings for the reel are carefully constructed, so as to allow of satisfactory lubrication, with the minimum amount of risk of oil getting on the yarn (see Fig. 4).

In the "parallel" doffing motion, shown in Figs. 1 and 2, which has some points of resemblance to the "bridge," there are two possible supports for the doffing end of the reel shaft. One support is inside or nearer to the reel than the other, and is to hold the reel during doffing, while the outside bearing is for the reel during working. As in the case of the bridge, the hanks are partially removed, and then the reel is smartly pushed across from the outside to the inside bearing, thus freeing the hanks and allowing of their ready removal. This is the simplest motion of all. The bearing on which the doffing end of the reel rests during working is composed of a special metal supposed to do without oiling. In some

cases brass bearings have holes drilled through, and the holes are filled with black lead under hydraulic pressure (see R.T. Fig. 2).

The "bridge" doffing motion is a light loose casting which helps to sustain the reel end when working, assumes a flat position when the reel end is pushed smartly forward, and again assumes a vertical position, but the other end up so as to fully release the previously half-released hanks of yarn.

The heavy "gate" motion which held up one reel end for doffing has almost disappeared.

The old "wheel" motion is still in great favour, especially in the Oldham district.

All such doffing motions obviate the need for a reeler holding up the heavy reel end for doffing, liberate the yarn readily, and may be worked without yarn being soiled or greased when taken over the reel end.

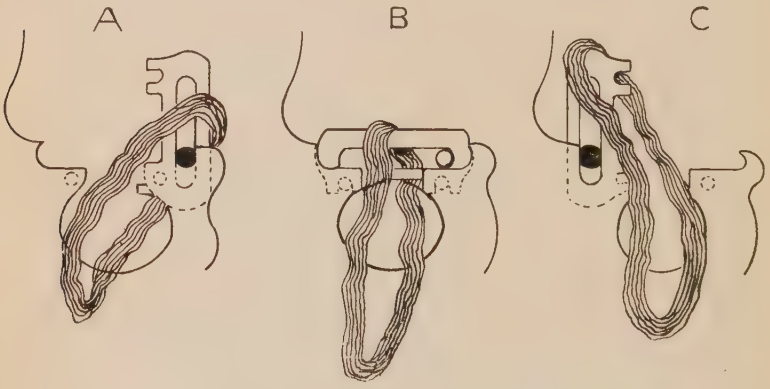

FIG. 4.

At Fig. 5 are shown three different creel arrangements for reels by Asa Lees & Co., and they are self-explanatory.

The Twisting Reel.—It is possible to obtain a reel which will slightly twist the yarn during its passage from bobbin or cheese to the swift. Such a machine may find its use when yarn has been wound several ends up on cheeses or double flanged bobbins. Each cheese or bobbin at the reel is carried by a revolving spindle with bolster and footstep, and driven from a central tin roller. As the ply-yarn is drawn from the creel bobbin the spindle of the latter may give a twist from one-half up to three per inch, so as to bind and twist the separate ends into a definite unit.

Single Reel.—Two rows of bobbins and spindles much after the principle of an upright spindle winding frame but lower down, with the yarn lifting to the swift. The driving is so arranged that

the r.p.m. of swift may be readily altered by change wheels, and the twist per inch thus altered in amount. Taking two turns per inch we may have a—

Production about 700 lb. per week of 48 hours.

Vertical Rack.—In 7-lea reeling the first lea is wound on the swift with the stepped vertical rack at the bottom. This rack is lifted one tooth for every 80 threads or revolutions or 1 lea of 120 yards from each cop or bobbin. After six moves the rack reaches its highest position.

With a movable traverse rail a spring draws the rail forward towards the rack, and for the depth of one step or tooth for each move upwards.

Six movements will give 7 leas.

With the movable table system it is the table that slides one

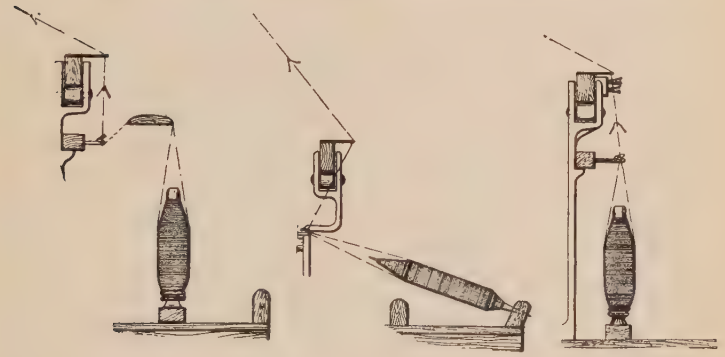

Fig. 5.

tooth each time. The table method is a good one for keeping all cops or bobbins in direct line with the guides since all go with the table. The seventh move upwards of vertical rack unlatches the stop rod.

45 inches and 72 inches are reel circumferences occasionally used.

When cheeses are reeled off and one end of a cheese is webbed or run off, the reeler should use for the leading end of cheese, that which is run off or webbed, and will thus diminish thread breakages.

After the separate tying a number of hanks may be matched together on the reel before doffing, using a separate tie-band.

Each set of hanks thus tied together comprise one knot or dole.

In the thread trade a 10 lb. bundle may be first strung together by the reeler, and all such bundles taken to the warehouse at the time for weighing-in. Four at a time is convenient.

Objects and Methods of Reeling.

Reeling of cotton yarn into the form of hanks or other lengths is often done as a convenience for export, while in many other cases it is done in order to put the yarn into the best condition for such treatment as bleaching and dyeing. The two chief kinds of cotton reeling are:—(1) Open or 7 lea reeling, (2) cross reeling. For export purposes alone "open" reeling is probably the favourite, and by this method a lea of 120 yards of yarn from each cop is wound on the reel, and then the guide rail—or in some cases the swift itself—is moved a short distance longitudinally in order to place the next lea upon a slightly different portion of the reel. This is a great convenience in tying up the seven-lea hank, as the tying up thread can readily be passed under or over each separate lea.

When the yarn is to be bleached and dyed the guide bar is made to have a continuous reciprocation over the length of reel required for one hank, so that the yarn is disposed in a more open manner, and the dye stuffs have a better chance of operating upon every portion of the yarn. It is necessary to use the ladder for seven-lea reeling, and the crank wheel for the cross reeling, and it is an easy matter to uncouple the guide bar from the one, and recouple to the other of the two parts specified.

In a great many cases the ordinary cross-reeling of one hank to itself is not now sufficient, and what has been termed grant reeling has come into favour. Grant reeling is an enlarged example of cross reeling in which a greater or more rapid throw is given to the yarn so as to obtain wider crossings and more open spacings in the yarn, and this permits much longer lengths to be wound in one piece, such as double-double hank, or more, while yet being convenient for the after process. Other special examples are four-lea reeling and skein reeling, a ladder rack with deep steps being often used for the former, while the latter may be done with a very slow forward traverse of the guide rail.

For yarns intended for France, what is termed French reeling is resorted to. Cotton yarns in that country are numbered on the metric system, and the metre of 39·37 inches in length is taken as the standard. The length of 1,000 metres is termed a hank or *écheveau*, and each hank is divided into 10 skeins. These skeins are wound on a reel of 56·122 inches circumference, as compared with the usual English standard of 54 inches.

Creel Arrangements for Reels.

Although not representing all the types of creel in use on reels, Fig. 6 represents some arrangements in use. Messrs. Asa Lee's excellent reel for ring bobbins is shown in Fig. 6.

The round brush for the yarn to go through prevents hard twisted yarn from snarling.

The yarn passes upwards inside the circular brush on its way to the reel as shown in Fig. 6.

Another type of tensioning and cleaning brush is shown in Fig. 5 at the right hand, an arrangement for mule cops in the centre and a plain board drag on the left hand. For reeling endways from quick traverse cheeses the yarn may simply pass over two upper plain round rods which permit all the yarn to balloon off the cheese.

Reeling speeds are rather harsh on sideways unwinding, but this could be provided if required.

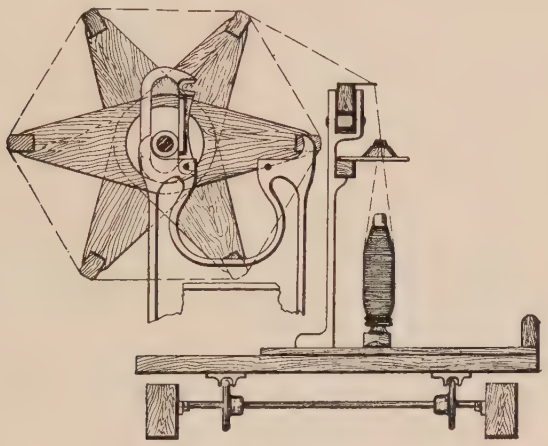

Fig. 6.

In Fig. 6 it will be noticed the reel table carrying all the cops or bobbins rests upon rollers, the roller shafts being placed at suitable intervals in the length of frame. The table is latched in position when working and for 7-lea reeling; every time a lea is reeled, the table is released and made to slide lengthwise, the distance required to separate one lea from the next. This method is a favourite in the Oldham area.

The bridge doffing bracket shows prominently in this sketch.

Details of Reels.

The relative position of the different parts should make a reel easy to operate.

The traverse motion if geared, therefore positive, makes it

impossible to wind other than a well-bound skein; consequently, the process of spooling, or other succeeding operation can be more rapid and less wasteful.

The bearing on driven end may be set in ball and socket joint, so that it cannot be strained in lifting swift for removing yarn. The bearing on opposite end entirely protected, preventing any oiling of skeins.

The releasing arms and traverse may be fitted with metal bearings, fitted with metal boxes.

The shaft may be of wood, ensuring lightness, and for this purpose is very good.

The bobbin box may have waste box at each end and protected from any drip from spindles.

Reels can be made fitted with front spindles to fit cops, spinning or twister bobbins, each spindle removable independent of others. Spindle bearings may have hinged protecting board, preventing dirt and flyings from lodging.

A gong can be attached to strike at the completion of each hank of 840 yards, or when any other length desired has been reeled.

Specifications for Reels.

Number of reels with driving pulleys on right-hand end.
Number of reels with driving pulleys on the left-hand end.
Number of spindles in each reel.
Space between spindles.
Size of swift desired (54, 56½, 72 or 90-inch).
Reel to be belted from (above or below).
Gong to strike at each (hank or—yards).
Yarn to be reeled from (spool, bobbin, cop or cheese?). Send sample full of yarn.
Remarks.

Very many reels are bought and sold second hand, a reel being a sufficiently durable machine, light, compact, easy to transplant, easy to pull down and re-erect. No section of the cotton trade appears more susceptible to ebb and flow of business. Some small firms do commission reeling and work more or less with yarn agents.

Other items requiring specification in ordering new reels run somewhat as below:—

Total number of reels? Single or double reels?
Number of hanks? Gauge or centre to centre of reeled hank, creel cops or bobbins? Length over all.
Width? Circumference of reel or swift?
Kind of reel or swift? Reel to have tin centre or loco centre?

Wood or iron swivels? Crossing motion?
Grant reeling motion? Seven-lea motion?
Skeining motion? Kind of drag motion?
Revolutions per minute diameter and width of reel pulleys?
Brake motion or not?

State if for reeling off the end of the cop or ring-spinning frame bobbin. If reeling from revolving bobbin is required, state if plain steel spindle with bolster and footstep rail or self-contained revolving spindle is required.

A sample bobbin or skewer should be sent to enable the brackets to be suitably drilled to receive the skewers, or for the split wood plugs being made suitable for the bobbin.

Pulleys, Speeds, Reel Details.

Reel pulleys are only small, say 1½-inch wide × 6, 7 or 8-inch diameter. Usually two girls will mind one 40-hank double reel, the revolutions per minute taken at about 250, which is a high speed.

When winding endwise from ring-frame bobbins, 54 inches circumference × 3½-inch gauge is much used. Such a reel may turn off at the rate of 450 hanks per hour.

A reel for ring-frame bobbins is usually double, or has a reel for 40 hanks on each side, the creel being in the middle and higher up with the yarn coming downwards to the swift.

A single reel has only one swift, occupying the body of the machine with the creel cops or bobbins in front, lower down, the yarn travelling upwards from creel to swift.

Closing-in Motions.

For very strong yarns and long hanks two staves may be arranged to be released, and then dropped towards the centre, to slacken the hanks for doffing. This is termed the *drop motion.*

For ordinary yarn counts, strengths, and lengths, the reel is made to close up for doffing, this being termed often the "book motion." An automatic brake is used to bring a high speed reel quickly to a standstill.

Ring throstle bobbins may either be mounted on revolving spindles for side unwinding, or upon split wood plugs or bushes for end unwinding. Side unwinding is easily tensioned. Special drag brushes may be used for end unwinding.

Length on Reel.—It is occasionally difficult with ordinary reel measuring motions to obtain exact reeling lengths, although it is a matter of distinct importance. In actual business some allowance is made for this, and about 2 per cent. variation may be permissible,

such as allowing a hank of about 820 yards to pass instead of 840 yards. Over-running of reels is undesirable even if the first leas of the next knots are correspondingly short, equivalent to the excess length of the over-run ones. A good knocking-off motion will ensure correct lengths. A reeler may omit to stop the reel when a cop or bobbin runs empty. When yarn is sold "scale" weight, occasionally customers are not very troublesome in regard to exact reeling lengths.

In some cases a 10-lb. bundle is passed at not more than 2 oz. light or 1 oz. heavy, with counts satisfactory. Coarse wrapping and reasonable accurate reel lengths sometimes make a bundle distinctly more than 10 lb.; unless checked by reeling a few threads short, to get the correct weight even with counts too coarse, reels slightly too small in periphery—possibly due to wear, a worm-wheel of one or two teeth below 80, and definite reeling of short lengths of coarser counts, have been charged against reelers before now.

Over-conditioned yarn from spinners is apt to dry in reeling, and upset the proportions of counts and weights.

Business has increased in reeling over the end of cheeses of yarn, and sometimes these cheeses are run off the end. Experience shows it is best for the run-off ends—or the worst ends—to be put on the top.

To get the well-known and desired crimp in extra hard twist yarn, it is best to condition *after* reeling and *not before*.

Reeled hanks may be conditioned on the wet cloth application system.

Reel Centre.—Double-hank reels may be made with an adjustable bearing to support the rails and bobbin boxes in the centre of the reel.

The centre of the reel may be constructed of tin for single cop reels, but for reeling hard-twisted or double yarns, on the double reel, the barrel is made of an iron loco tube. The swivels are made of wood if applied to a tin centre, and of iron if applied to loco tube, the long staves may be made of well-finished pine, but can be made of baywood if required.

Drop Motion.—As before stated for doffing purposes the more usual method is to close up the swivels to slacken the yarn, but if hard-twisted single yarn be used, or heavy doubled yarn the drop motion is usually applied to one or two of the staves. A locking hinge is applied to the swivel, which, when unlocked, allows the stave to fall in and loosen the hank. Side unwinding gives tighter yarn on the swift than end unwinding.

Creels.—On single reels using cops the creel is placed in front of the swift, and skewers may be carried horizontally from a wood rail. To reel off the end of ring bobbins the wood rail is fitted

with split wood plugs to hold the bobbins. A suitable yarn guide rod is provided. A row of revolving spindles down each side of the frame when side unwinding from two-ended bobbins.

It is made convenient in any reel to change quickly from "open" to "cross" reeling, or vice versa.

The stepped rack usually controls the length knock-off motion for all kinds of reeling. The stop motion not only moves the belt on the loose pulley, but also in single high-speed reels, it applies a brake to the fast pulley.

Side Unwinding.—For sideways unwinding from flyer bobbins or ring doubler bobbins, each bobbin may be carried by a plain revolving spindle. For this work, reel 54 inches circumference, 40 hanks double, $3\frac{1}{2}$-inch pitch, specially strong lap-welded loco-tubular centres, drop motion. Low speed, say 140 to 150 r.p.m., giving up to 300 hanks per hour, this being rather high but possible with good work and smart operatives.

Reels are often used for reeling from gassing-frame cheeses, which are usually short, and are very conveniently placed in a central creel, the threads guided first upwards and then down to the reel, double reels being customary.

Double v. *Single Reels.*—Single reels are in favour for reeling from cops. Double reels may be used for operating on gassed cheeses or large taper bobbins over the end, double-flanged bobbins sideways, or ring spinning bobbins endways.

A double reel may be 4 feet 2 inches wide, and a single reel 2 feet 10 inches, but dimensions vary slightly with the makers.

Seven lea reeling most used for export and cross reeling for dyeing, motions for each of these effects being part of a standard equipment. A reel must allow for quick and easy changing from one of these to the other.

Grant or diamond reeling is associated with long lengths—up to 10 hanks or 8,400 yards being possible. Large crossings, long lengths, and wide pitch on a definite basis, to prevent entanglement in dyeing.

A general view of one of Messrs. Schofield's reels is given in Fig. 7.

Notes.

Each swift, with its traverse motion, is driven separately. For a single reel a pulley 6 inches diameter × $1\frac{1}{2}$ inch wide; for double reels an 8-inch diameter × $1\frac{1}{2}$ inch.

Moderate speeds are 100 r.p.m. for side unwinding, 150 r.p.m. for end unwinding, mule cops or ring bobbins, six double 40-hank reels = 1 i.h.p. for yarns 20's to 30's single yarn.

Four doffings per hour from each swift when reeling 40's/2-fold

from double-headed doubler bobbins. Five doffings per hour

Fig. 7.

20's/30's single yarn, over the end of ring bobbins or mule cops.

Fifty hanks long for 3-inch gauge, 40 hanks long for 4-inch gauge, are full sizes.

When reeling 20's/30's ring yarn, one reeler for 50 hanks, $3\frac{1}{2}$ gauge of frame.

For skeining purposes, or reeling the yarn in a slow progressive spiral, and into lengths other than the standard seven leas = 1 hank, the skeining motion may be worked by a screw, but can be a clock-skeining motion worked with a wheel.

For end unwinding of ring bobbins—especially if the yarn is well twisted—the thread may pass through a "Noton's" circular brush.

Other kinds of brush for reeling from soft-twisted single yarns.

The skewers should fit well in their bracket holders and should also be a good fit inside the cops.

The circumference of a reel is designated as one thread, the standard English circumference is 54 inches, 560 revolutions or 560 threads = 840 yards = one hank and 80 revolutions one lea from each cop or bobbin.

Reel Strap Hook.—The arms of a reel are usually kept open by means of a short and narrow strap which is hooked in position again every time the reel is to be used, and unhooked for collapsing and doffing purposes.

When reeling from revolving ring or other bobbins, the thread is wrapped very tightly round the swift by the resistance of the creel bobbins. In such cases the drop system is often used instead of the unhooking of the narrow strap just mentioned.

For end unwinding from cross-wound gassed cheeses, special creel and drag arrangements may be used on the reel. Two heights of rails, porcupine arrangement, guide rods, and a series of glass rods for producing the drag.

Circumference of Reel.—In commencing, the reeler "hooks on" the ends to the staves in a fashion which holds these ends firmly when the reel starts and works, and although the reel of 54 inches or $1\frac{1}{2}$ yard is by far the more used, yet other circumferences are in use for special purposes, such as $56\frac{1}{5}$ inches, 90 inches, 72 inches, and 45 inches.

$56\frac{1}{4}$ inches or 56·222 inches is more especially for the French trade to accommodate, the metre of 39·37 inches, and the half-kilogramme of 1·10238 lb., as explained elsewhere in this chapter. The hank may be made up of 700 rounds, in five skeins or so-called leas of 140 each, giving 1 kilometre of 1093·63 yards.

The 90-inch periphery of reel is quite regularly used for making long bundles in the sewing thread and crochet thread trades.

The 72 inch may be occasionally used for the carpet trade and the 45 inch for a very small amount of foreign trade.

Polishing.—There is a certain amount of reeling done in preparation for hank polishing as explained elsewhere, but in mills of any size, giving large productions—especially in the thread trade—it is generally found much more economical to polish the yarn in warp form, possibly 360 threads passing in line under treatment of the polishing mixture and revolving brushes.

The 90-inch reel for sewing thread, being much heavier and of larger diameter than the standard 54 inches, must revolve more slowly—say, about 80 for the 90 inch against 170 or so of the 54 inch, and light reels, winding good yarn from bottle-shaped bobbins, have been run at 300 r.p.m., which is a very high speed even for a light reel.

Knittings.—The standard of 7 leas or 840 yards is occasionally departed from, while still working on the principle of specified lengths having specified weights.

Four-lea reeling is much used for knittings, the yarn being reeled into so-called 2-oz. hanks, in 4-leas, so that each lea represents $\frac{1}{2}$ oz.

In some cases a 4-lea vertical stepped rack has been obtained by filing away three alternate steps of the ordinary 7-lea rack, thus giving a double length of lift at each movement, and correspondingly a double length movement of thread guide rail.

This facilitates the accurate tying up required for these $\frac{1}{2}$-oz. skeins or so-called leas.

The knitting yarn is often wound upon larger bobbins than customary and one placed on every other spindle, reducing a 40-hank reel to the capacity of 20 hanks, the low counts of yarn also favouring this.

Stop-motion Reels.—About 1896 the writer often came across these, but they appear to have receded rather than gained in favour.

A 40-hank reel might be divided into four parts of 10 hanks each, an automatic stop-motion applied to each of these, and only 10 hanks stopped at one time for piecing up or other purposes. The apparent time-saving of these Coleby's reels has been accompanied by disadvantages which have restricted their adoption. The application of a single thread stop motion is of course inadvisable for a 40-hank reel, and even in the sectional 10-hank reel, with only 10 hanks stopped at one time, the additional first cost complication and cost of upkeep are of doubtful advantage. Some reeling firms have kept a few of these reels for special purposes. Introduced about 1880 by Mr. Coleby and since improved in detail. Where the correct number of threads is *demanded* in each lea, learners may be put to skewering cops and piecing broken threads on 10-hank sections, leaving the tying up and doffing of hanks to a careful and competent reeler.

Measuring Motions.—The most usual size of worm wheel or measuring motion wheel contains 80 teeth, but certain other sizes can be applied for special purpose. Special features for attention are: skeining motions, 4-lea stepped racks, cross-reeling, open reeling, different combinations of bevel wheels for driving the worm-wheel shaft, different sizes of worm wheel for different reeling lengths, automatic full-length stop motions, brakes to stop the reel quickly, collapsing motions or drop staves, special creel arrangements for cops, ring bobbins, gassed cheeses, bottle bobbins, soft yarn, crêpe yarn, tension and guide arrangements, doffing motions.

English Cotton Yarn Table.

1½ yards = 1 thread or circumference of wrap reel.
120 yards (80 threads) = 1 skein or lea.
840 yards (560 threads) = 7 leas or 1 hank.
The number of hanks per lb. = the counts or numbers of yarn.
A bundle is the required number of hanks to make 10 lb. in weight.
The number of yards weighing 8·33 grains is the number or counts of yarn.

English Weights for Cotton Yarns.

24 grains = 1 pennyweight (dwt.) troy.
18 dwt. 5½ grains (437·5 grains) = 1 ounce (oz.) avoirdupois.
16 ozs. (7,000 grains) = 1 pound (lb.) avoirdupois.

To reduce metres per kilogramme to yards per pound, and thence to obtain the counts of yarn (English):—

Rule.—Divide the number of metres per kilo. by 2·015, or, approximately, by 2, and the quotient will be the number of yards per lb., which, divided by 840, gives the English counts of yarn.
Example.—80,000 metres per kilo. or 40's French counts.

$\frac{80{,}000}{2}$ = 40,000 yards per lb. *And* $\frac{40{,}000}{840}$ = 47·6 counts English.

Weights and Measures and their Foreign Equivalents.

The metre is the unit for the metric system, and is the ten-millionth part of the quadrant of the meridian, being equal to 39·37079 English inches. The 100th part of a metre is the centimetre. The system was first adopted in France in 1790, and is now legally established in Austria, Belgium, France, Germany,

Italy, Portugal, Spain, Norway, Sweden, Bulgaria, Holland, Switzerland, the greater part of South America, and the United States; in other countries where the system has not been made compulsory it is not yet in common use.

English—Metrical.

Troy Weight.

Grain	=	0·064 grammes.
Pennyweight (24 grs.)	=	1·555 ,,
Ounce (20 dwts.)	=	31·103 ,,
Pound (12 oz.)	=	0·373 kilogramme.

Avoirdupois Weight.

Dram	=	1·772 grammes.
Ounce (16 drs.)	=	28·349 ,,
Pound (16 oz.)	=	0·453 kilogrammes.
Quarter (28 lb.)	=	12·700 ,,
Hundredweight (4 qrs., or 112 lb.)	=	50·802 ,,
Ton (20 cwt.)	=	1016·048 ,,

Lineal Measure.

1 Inch	=	2·539 centimetres.
1 Foot	=	30·479 ,,
3 Feet (1 yard)	=	0·914 metres.
Fathom (2 yards)	=	1·828 ,,
Pole (5½ yards)	=	5·029 ,,
Furlong (220 yards)	=	201·164 ,,
Mile (1,760 yards)	=	1609·314 ,, or 1·609 kilometres.

French Reeling.

The hanks wound for delivery (*a*) in this country, (*b*) in France, (*c*) for re-winding, (*d*) for bleaching. The tying of the hanks.

For delivery in this country it is a common practice to reel the yarn into hanks of 840 yards each. Sometimes double hanks of 1,680 yards are wound. Below is given a much fuller comparison of the French and English systems. By the English system of numbering yarns is understood the number of hanks of 840 yards each which go to make a pound of 7,000 grains. So largely has the cotton spinning industry been ruled by England that the English system of numbering yarns is in almost universal use throughout Germany and Switzerland. In France, however, the counts or numbers of yarns are based on the metric system. In this case the metre of 39·37 inches is the standard of length, and the kilogramme of 2·2047 lb. is the standard of weight.

In numbering cotton yarn a thread of yarn 1,000 metres long, weighing 500 grammes (half a kilogramme), is taken as No. 1, so that—

2's yarn in French = 2,000 metres, weighing 500 grammes.
4's ,, ,, ,, = 4,000 ,, ,, ,, ,,
20's ,, ,, ,, = 20,000 ,, ,, ,, ,,
60's ,, ,, ,, = 60,000 ,, ,, ,, ,,

The French number = 0·847 × English number.
The English number = 1·18 × French number.

The length of 1,000 metres is termed a hank (or *écheveau*), and each hank is divided into 10 skeins, the latter being therefore 100 metres each. These skeins are wound on a reel of 56·122 inches circumference as against the standard of 54 inches for the English system. 56·222 inches = 1·428 metres. The counts equal the number of hanks required to weigh 500 grammes. A working rule is to divide the metres reeled by twice the weight in grammes equals counts French. To reduce French counts to English we may multiply the French yarn counts by 1·18.

To reduce English to French counts we may divide the English counts by 1·18.

Without yet attaining much success, for many years attempts have been made to introduce a uniform system of numbering yarns. In the metric system the number of a cotton yarn indicates the number of times 1,000 metres (1093·63 yards) or $^{m}/_{m}$ required to make a standard weight of 500 grammes (1·102 lb.). The product of the weight and number is always the same, that is, 500. The number of the yarn is obtained by dividing the length by twice the weight.

Example: What is the counts of a thread, 60 metres of which weigh 5 grammes?

$$\frac{60}{2 \times 5} = 6.$$

With the French reel of $56\frac{1}{4}$ inches the reeling may be made up of 700 rounds, in five leas or skeins of 140 each, making the 1093·63 yards or 1 kilometre. The fraction is sometimes put at $56\frac{1}{4}$, and in some cases at $56\frac{1}{5}$, the more exact decimal being 56·222.

Tying up of Hanks.—Various points need attention in regard to tying up of reeled hanks. For example, in the case of double-double hanks for the preparing machine in lace yarns, very soft ties of good quality should be used, or there will be excessive breakage at the knots in the preparing process. The tie-yarn for preparing may consist of possibly fourfold wound together without twisting or of 3/40's soft twisted. Even then the attendant has to regularly replace tie-yarns after preparing.

In Grant or diamond reeling the crossing is arranged to give diamond-shaped openings which facilitate threading of the tie-bands. Since Grant reeling implies reeling in long lengths and

much over-lapping of threads, the importance of the diamond-shaped openings for tie-bands becomes very apparent. Any number of hanks up to ten may be wound together in Grant reeling.

The tie-up for ordinary cross-reeling is very simple. The tie-band is just threaded once round the entire hank and the two ends of the tie-band, and tied in with one or both the ends of the hank according to the class of work. The ends of the hank are afterwards readily found with the tie-band. A hank of 8's condenser yarn will naturally take a longer tie than an exact hank of 2/80's and tie-lengths are sometimes specified. If the hanks are to be spread out widely at next process longer tie-bands are wanted.

Ring Tie.—In what is termed ring-tie reeling the tie-band takes the form of the figure 8, each end of the tie-band passing under one-half of the yarn and under the other half before tying, so that each half is enclosed in one-half of the figure 8. The ends of the reeled

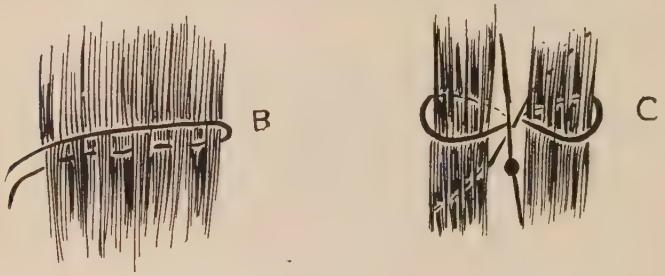

Fig. 8.

yarn may be tied together independently of the tie-band. Instead of the ordinary lea of 120 yards, a lea length of 210 yards or 140 revolutions of reel may be used, representing two revolutions of a 70-tooth worm-wheel instead of the standard 80 teeth. This arrangement gives freedom to the tie-bands under the influence of the brushes in hank polishing as elsewhere explained. If only one lea is tied up then one-half of the figure 8 simply encircles the knotted thread of the reeled lea which occupies the other half of the figure 8.

In skein reeling a special arrangement is applied to the machine which divides out the yarn into separate short lengths, each of which is a fraction of 1 oz.; such as $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$ oz., each division being termed a skein. Each skein may be tied up to itself or otherwise as required.

In 7-lea reeling the tie-band is simply threaded under and over each lea in a continuous looping or chaining, so that each loop contains a lea.

At B the ordinary cross-reel tie with tie-up band fully round *all* the yarn and both ends of tie-up string secured with the leading end of reeled hank to find the end easily; or if required with all four ends tied together.

For the ring tie or figure of 8 at C, the tie-band with 2-lea reeling may pass under 1-lea or portion of yarn and over the other on the one passage across the yarn, and then reverse this order on the return so that a figure of 8 knot tie is obtained. The leading and finishing ends of reeled yarn may be tied together but not to the tie-band.

The tie-band in this case not being fastened to the ends of reeled yarn, becomes free to move loosely about without breaking, in the case, for example, of hank polishing.

Directions for tying up often accompany orders for the work, and there is a great variety of these.

Tying up is of course done before removing the yarn from the reel.

A 10 lb. bundle, for example, may consist of 2/60's, containing 30 knots or doles; each 10 hanks forming a knot or dole.

Doublers are often required to provide a great variety of tie-bands to meet all requirements, but a good range is from 4/36's to 4/20's, with possible distinctions in regard to grandrelle and colours.

Two-lea reeling has a certain vogue in two folds and there may be two so-called leas of 140 threads each giving $140 \times 2 \times 1{\cdot}5 =$ half a hank or 420 yards.

In single yarns 2-lea reeling may contain 150 yards in each so-called lea.

The tie-band may pass round each lea in the figure 8 style. The two ends of reeled yarn are suitable with the knot at the top.

Making up and Bundling.

A good deal of yarn is exported in the form of cops spun upon mules. Some of this is packed in boxes and a diminishing amount in casks. The casks will hold a considerable quantity of cops and stand a lot of knocking about without damage, but they are awkward to pack. The tendency has been to favour packing in boxes or cases specially made of a cheap and flimsy character, so that they need not be returned when empty. Packing cops in this manner is not much trouble, although, of course, care should always be exercised that the cops are not damaged, the boxes being lined with paper. An increasing amount of yarn spun upon ring-frame bobbins is cross wound into cheeses upon the winding frame, and exported in this form. A considerable portion of yarn is reeled

and bundled, both spun on the self-actor mule and upon the ring-frame, this being an old-established and very convenient form of exporting yarn. A good deal, of course, depends upon what the yarn is intended for abroad as to whether it must be packed in the cop or bundle form. Suppose, for instance, pin cop weft may be bought for placing in the shuttles of the foreign looms without dyeing or other preliminary process whatsoever, it would obviously be best to pack such yarn in the cop form. When yarn is intended to be bundled it is first wound into hanks upon the reel, where it may be cross-reeled or 7-lea or open reeled. The cops being put upon skewers, the threads are attached to the reel, and the latter revolved until, say, one hank, or 840 yards, is unwound from each cop. The hanks are then properly tied and the reel closed up so as to allow of the hanks being withdrawn. Afterwards the hanks are made into knots and placed on the table of the bundling press, so as to make a bundle of 5, 7½, or 10 lb. weight, the latter being the most common weight. The number of hanks in a 10 lb. bundle clearly will depend upon the counts of the spun yarn. For instance, a 10 lb. bundle of 40's would contain 400 hanks, and one of 50's would contain 500 hanks. A press is usually arranged so that the bundle can be tied up with four strings, and often special paper and tie-up string are used, the details of a make-up being varied to meet the requirements of customers. For the home trade a very large amount of twist yarn is sold by the spinner in the form of warps from the beam warper. More so for ring twist.

Sample Order for Bundle Yarn.

10 lb. net, 40's, 36 lb. test, grandrelle, 20 hank halshed 8, blue facing, backs, no type stamp, black press twine, full length.

It is the most usual practice to make bundles of 10 lb. weight, but sometimes 5 lb. bundles are made; and while it is customary to make presses for 10 lb. bundles, it is also usual to supply lining blocks for the yarn box for the purpose of reducing its size to suit 5 lb. bundles. Occasionally 7½ lb. bundles are made.

In the case given there must be 10 lb. net weight of yarn apart from packings or banding. The yarn must be 40's counts, and a lea or 80 threads must pull to a minimum of 36 lb. on the strength testing machine. Grandrelle tieing-up thread for the hanks must be used, the thread being composed of two or three colours of yarn doubled together. 20 hanks halshed 8 means that 20 hanks are halshed together by a figure of 8 knot, so that 10 hanks will be in each loop of the figure 8.

Blue facing means that a piece of blue paper must be placed at that end of the yarn box nearest the maker-up, and where the hard

ends of the knots are, being held in position by being passed under the backing paper and tied.

"Backs" consist of very stiff paper or a kind of card-board being placed on the top and bottom of the bundle and tied up with the string.

No type stamp means that the counts or identification marks should not be stamped on the bundle. Black press twine means that the four strings used to tie up the bundle while in the press, and before the wrappers are put on, should be black in colour.

Full length means that every lea should contain 120 yards and every hank contain 840 yards.

Each knot contains $10 \times 2 = 20$ hanks, and there must be 10 lb. $\times$ 40's counts = 400 hanks in the bundle; so that we shall have $400 \div 20 = 20$ heads of knots showing at the face of the bundle.

It will be noticed that by having a 10 lb. bundle we need only to add a cypher to the counts to find the number of hanks in the bundle. Thus with 10's yarn there would be $10 \times 10 = 100$ hanks in the 10 lb. bundle; with 60's counts there would be $60 \times 10 = 600$ hanks; with 20's counts there would be $20 \times 10 = 200$ hanks; and so on.

The Bundling Machine (see Fig. 9).

A bundling press consists of the yarn box, the movable table on which the yarn is laid inside the yarn box, and the requisite mechanism for giving the proper motion to the table. The use of the machine is to press a suitable quantity of yarn into a compact bundle, 10 lb. being the most usual weight taken.

The yarn box is formed by a series of strong bars projecting upwards on each of two opposite sides of the machine. Between each pair of bars space is left for a tying-up string, there being usually four strings permissible. Packing paper and sometimes stiff "backs" are placed on the strings and the knots of yarn placed on the paper; sometimes, however, no paper is used until the bundle is removed.

It is possible to turn the machine by hand, as there is always a fly-wheel conveniently placed for the purpose (or else a large four-way handle). Modern presses are usually fitted for power driving, and the belt being put upon the fast pulley, in Coleby's press the double purchase of very strong gearing is thereby rotated.

Two small but very strong wheels drive two very large ones in order to give a slow powerful upward motion to the press table.

Practically forming part of the second and largest driven wheel, and revolving with it, are two large cams—one on each side of the wheel.

The cams practically support the press table, and their rotation forces the yarn upwards against the strong top cross-bars until a sufficiently compact bundle is formed. When the table has been lifted high enough the belt is automatically moved upon the loose pulley so as to stop the press. The table is held in position by a catch and ratchet wheel while the tying-up is done. The yarn

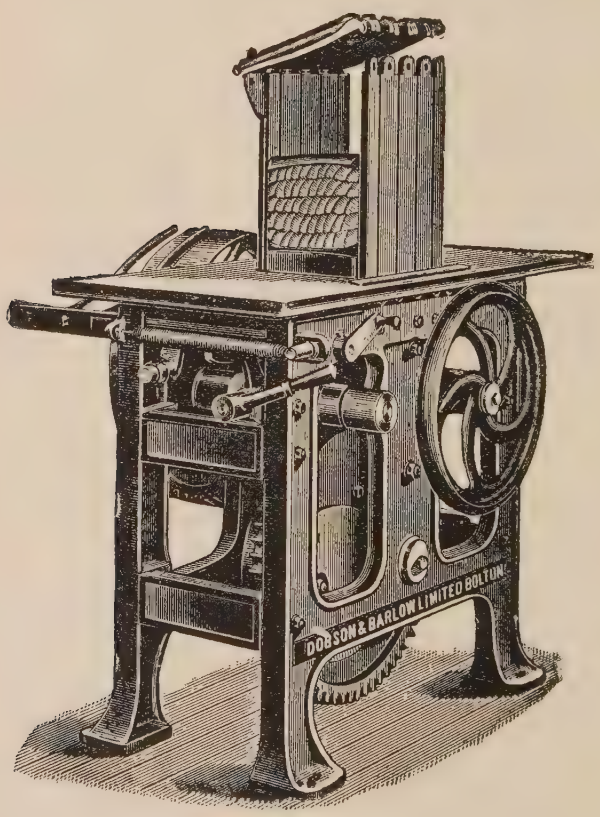

FIG. 9.

table or base is lowered and the top cross-bars automatically released, so as to permit the ready removal of the bundle. After removal the making-up of the bundle is finished.

Noticeable features of Coleby's press are the strong lifting cams instead of levers; the self-locking and self-releasing of the top cross-bars and automatic knocking-off motions.

A general view of one make of press is given in Fig. 9, and there is little difference between this and other modern makes.

Referring to Fig. 9, this press is made from approved patterns, arranged to be driven both by hand and power, and will make bundles 10 lb. each.

Strong planed cast-iron framing; yarn box 12 inches long by $8\frac{1}{2}$ inches wide, with four strings; improved double eccentric lifting motion for lifting press table, with extra strong gearing, and polished wood table.

Extra block and linings to make bundles 5 lb. each are supplied when required to fit the press.

Power.—1 i.h.p. per press.

Production.—About 9,000 lb. per week of forty-eight hours.

Making Up.

The yarn box of the press is usually prepared for four strings, and may measure 12 × $8\frac{1}{2}$ inches when fitted with the ordinary loose birch-wood base. Loose birch-wood linings are provided when it is intended to make 5 lb. bundles as well as 10 lb.

The automatic knock-off motion ensures equal pressure on all bundles.

Lifting the press table by two strong cams has largely superceded the method of lifting by levers; the eccentrics or cams are very durable, very strong, and very free from any locking or wrong action. If intended for occasional or regular hand working, a capstan wheel is applied instead of the ordinary hand wheel or fly wheel.

Power varies with the pressure put on the yarn bundles, but need not be taken at more than 1 h.p. per machine.

A polished bay-wood making-up table to fit the press, with knotting hook, may be applied if desired.

Pressed bundles of 10 lb. each are most common, but 5 lb. is sometimes the weight, and $7\frac{1}{2}$ lb. is not unknown, while for the French trade the pressed bundle may be 11 lb. to suit the metre and kilogramme.

Knots of Yarn.—The hanks are knotted before putting in the press, and knotting tables must be of very smooth hard-wood to prevent threads from catching. The polished metal horn or knotting stick is conveniently placed so that the yarn may be placed on the hook and jerked out straight by the right hand of the maker-up.

A small but rather peculiar part twist is given so as to form a good loop in the middle, and this makes the head of the knot.

A knot of yarn contains the required number of hanks, and the knots are arranged in layers in the yarn box of the press. Heads of knots to the left hand, other ends of knots to the right, so

many knots to the layer, and sufficient layers to give the required weight of bundle, so long as counts of yarn and reeling lengths are sufficiently accurate.

The Press.—In a modern press the sides are of fixed steel bars with four vertical slits for the four tying-up strings. The top cross-bars are of steel and arranged to automatically open or shut when the bundle table reaches certain positions, the bars being hinged at one end, and self-locking at the other end. The base or hard-wood press table also has four grooves for the tying-up strings. There are small holes in the press table to receive the ends of the strings and four balls of tying-up twine may be placed beneath the press.

The top and bottom of each pressed bundle may be protected with cardboard inside the wrapping or paper cover, the lower cardboard being put in before the yarn, the top backing being placed on top of the yarn in the box. A slip of tissue paper may be placed underneath the top backing and may hang down in front of the knots of the hanks.

After pressing, the tying-up strings are fastened with tightly-drawn slip knots, secured with check knots. The bundle will be removed after the press table has been lowered.

Bundling Press Details (Figs. 10, 11).

Fly-wheel, R, and driving pulleys are on same shaft as strong pinion wheel, P, which drives Q, and a second pinion, O, drives final large wheel C, which carries on either side of it the large lifting cams, B, B.

Each large cam, B, acts on a bowl, E, connected to the lifting table, so that the table rises and falls in obedience to the outline of the cams.

At the top right hand (marked Fig. 10A) is a separate view of the mechanism for automatically sliding and unlatching the top steel bars of the yarn box when sufficient pressure has been exerted.

The strap rod is automatically released when the yarn box reaches its highest point. Various items, such as the cam, B, the four wheels, P, Q, O, C, are shown separately in Fig. 11.

Unpressed Bundles.—Long unpressed bundles are commonly made for some classes of home trade, such as for condenser and preparation, or very low counts cotton yarn. The lower counts and qualities of these may often be seen in transit by road or rail, with no covering except an ordinary sheeting for the lot. Sewings, crochet, knittings, and various other classes of goods also are mostly made up into long unpressed bundles. Individual hanks are pulled straight on the knotting hook and each end of the hank rolled to form a crude form of head in order to keep loose threads intact.

The hanks are laid parallel in a wooden or metal box possibly 12 inches deep and 22 inches long × 6 inches wide. At each side are arranged five bars with four spaces of inch width for the tying-up strings after the style of the pressed bundles. Each bar about 4 inches wide.

For the condenser, preparation, and heavier sorts of soft material and hosiery, about 10 lb. may make a bundle, but for finer and harder twisted sewings a bundle may reach 15 lb.

FIG. 10A.

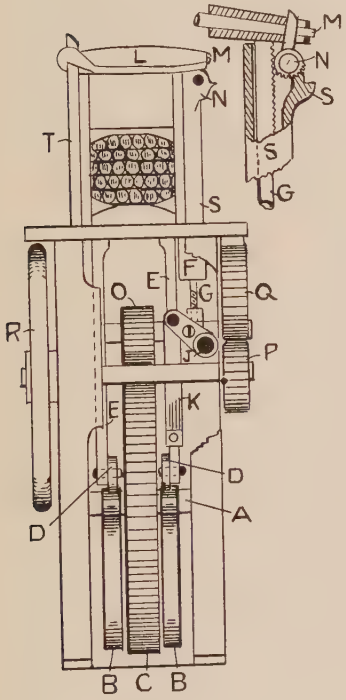

FIG. 10.

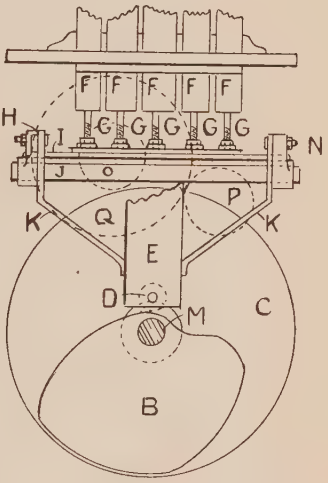

FIG. 11.

Long bundles may be prepared from yarn either from 90-inch or 54-inch reels, the latter bundles to equal 24 inches long × 7½ inches wide, 6 inches deep for the 15 lb. sewing bundles or 5 inches for the 10 lb. soft yarn bundles.

Bales of Pressed Bundles.—As stated, long bundles of coarse preparation and condenser yarn are often sent in a very unprotected condition and in quite a loose form in this country.

For better sorts of goods such as sewings, and for sending

some distance away, or for export generally, a number of yarn bundles are often put together and pressed into one bale. For export purposes a hydraulic press for making bales of yarn bundles should be part of the equipment, common sizes being full bales of 1,200 lb. or half bales of 600 lb. It is aimed to obtain good cubes of yarn from the hydraulic press in bale form, so the number of bundles and number of layers are carefully disposed so as to obtain the cube. The long bundles may be laid alternately crosswise and lengthwise. Hoop iron may be used for binding up the bales. Hemp or other covering for the bales, interlined with rain-proof or pitch-proof cloth and again with good paper next to the yarn. These precautions prevent staining and damage of the yarn in transit. The bale-covering cloth well stitched together.

Wood logs may be used to fill in the space between the top of the bale and top side of press before starting the pump for the hydraulic press.

Common sense must be used if other protection is needed for the bales of yarn.

Inspection of Hanks. Make-up.

After reeling or preparing, good, expensive yarns are often examined for one defect or another, such as broken ends, or broken tie-bands, many sorts of less expensive yarns are not very specifically examined.

A reeler may have done some cross-tying up of the hanks, portions of one hank or lea may have got fastened to another one, the yarn itself may contain bad knots, oily portions, snarls, be imperfectly cleared, or possess other defects, counts of yarn may have been mixed, "corkscrewed" or "single" yarn may have got in. Hence the use of a yarn examiner.

From a spinning mill, yarn may leave in the form of cops, ring bobbins, export tubes used on the ring-frame, in reeled and bundled hanks, in cheeses or cones from the winding frame, or in one or another form of warp. Cop, bundle, warp, and cheese are prevalent forms.

From the Doubling Mill.—Doubling mills make up the yarn as required in bundle, twiner cop, cheese or cone, warp of some kind. Thin packing cases, non-returnable, or returnable casks for export, stronger and returnable packing cases for home trade, packing skips also for home trade especially.

Bleaching makes yarns finer and lighter, so if net weight 10 lb. bundles are required after bleaching, the weight must be possibly 6 to 10 per cent. greater in the unbleached state.

This problem is not met with in the grey yarns, and in these a 10 lb. bundle is often 1 to 3 oz. too light, especially if the yarn has

been well conditioned and then allowed to stand in a warm dry place.

Production.—Calculate 230 doffings per week of forty-eight hours from each swift on yarns about 28's when reeling over the end of cop or ring bobbin. Take four-fifths of above on 40's/2-fold, and reeling from revolving two-headed doubler bobbins.

Reels stop so much for doffing that productions are affected by these operations almost more on reels than any other cotton machines.

In one case it is calculated that six double 40-hank reels on 20/30's yarn require one horse power.

Double reels are usually more strongly built than single ones, and are in general use for reeling doubled yarns from revolving bobbins.

Sometimes also for high speed reeling of single yarns from ring bobbins and cops.

The clock-skeining motion may be worked with a wheel and the ordinary one by a screw.

CHAPTER II.

WINDING.

Winding Frames.

The fundamental object of winding is to transfer single or doubled yarn from one kind of package or condition of make-up, to some other form better suited for some special purpose. Usually also the yarn is cleared at the same time. There is very great variety in kind and make of winding frame.

Winding frames may be quick traverse or slow traverse; vertical spindle or horizontal spindle; single drum or double drum; split drum or plain drum; constructed to wind fine yarns on the one extreme, or banding on the other extreme; fitted to prepare parallel cheeses, cones of yarn, bottle-shaped bobbins or warper's bobbins. Winding frames may or may not have stop-motions for broken threads. Weft-winding frames will build very hard cops.

Winding frames of one kind or another are used in spinning mills, doubling mills, weaving mills, and hosiery works, and there are very many makes.

A cup or pirn winder prepares yarn in cop form for use as weft in the shuttle of the loom.

There are various modern frames which wind and shape the yarn in cop form, without using the cup principle and without needing to use a pirn.

Many patented forms of cam traverse motion have been more or less used in winding frames—especially of the quick traverse kind.

Either mangle wheels or cams may be used to give the slow traverse of the upright spindle winder.

The term "clearing frame" is often applied to the upright spindle winding frame when used for doubled yarns.

Upright Spindle Winding Frame, Single End, with Cam-Lifting Motion.

For single end winding in the plain weaving trade the upright spindle is most common.

Upright spindle winding frames were formerly more often made

with cam-lifting motion, but for some years have been more often made with one form or another of mangle-wheel motion. Winding for warps may be done at the spinning mill, but is more often

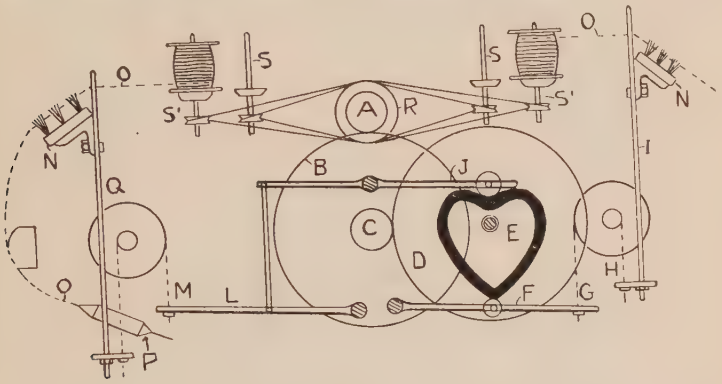

Fig. 12.

the first process in a weaving mill. In Fig. 12 a skeleton outline of one form of cam-lifting motion is given.

The wheels, A, B, C, D, operated from the tin roller shaft, R,

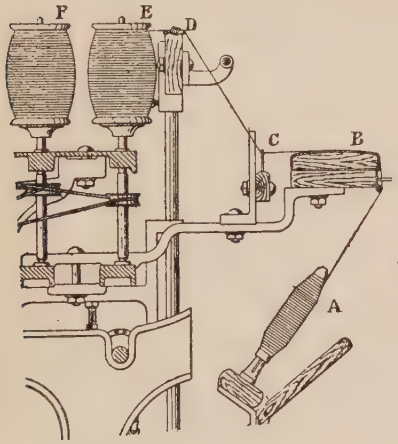

Fig. 13.

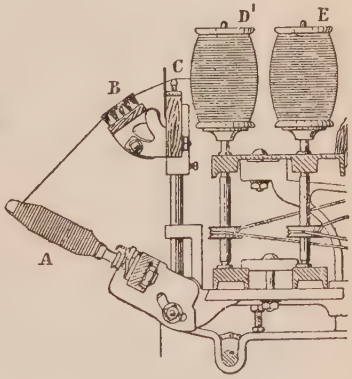

Fig. 14.

give a slow continuous rotation to the cam, E, which simultaneously operates an upper lever, J, and a lower one, F.

On the right hand the depression of lever, F, by the full part of cam, E, draws a chain, G, from its bowl and winds the chain, H, on

another bowl or pulley. This draws the vertical rod, I, the brush, N, the yarn guide and the yarn, O, upwards so as to place the yarn from bottom to top of bobbin. At the same time the yarn on the opposite side is wound from top to bottom of its bobbin by lever, J, and L, and their connections.

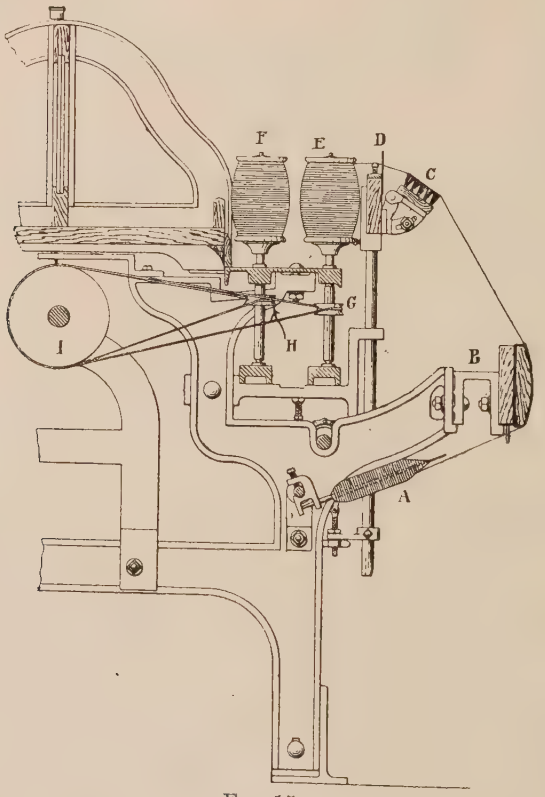

Fig. 15.

A slight rounding on the two sides of the cam, E, and a slight sharpening of the point and hollow of cam, give a lifter traverse which is slightly slower for the centre of the bobbin length, and this gives a barrel shape to the bobbin so that it will hold more yarn without increasing the diameter of flanges. Many people prefer the straight bobbin without barrelling effect.

Back row spindle wharves, S, S, $1\frac{1}{2}$ diameter, front row S′, S′, so that half-full bobbins are transferred from front to back rows to

prevent an excessively high winding speed for full bobbins. Cases exist where both front and back wharves are the same diameter.

Vertical Spindle Winding Frames.

Figs. 13, 14, 15 are diagrammatic views of three systems of vertical spindle winding frame as extensively used for the winding of single yarns.

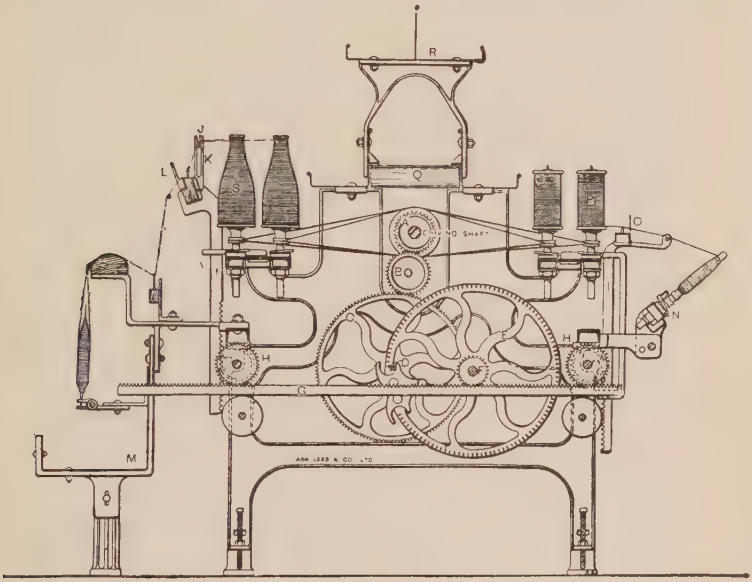

FIG. 16.

References to Diagram.

A Wheel on tin roller shaft, 30 teeth.
B Carrier wheel, 68 teeth.
C Stud wheel, 90 teeth.
D Mangle wheel pinion, 6 teeth.
E Mangle wheel, 122 teeth.
F Change wheel, range 26 to 34 teeth.
G Long rack.
H Wheels on ends of lifter shafts, 39 teeth.
I Lifter racks.
J Wrought-iron bar for tapering motion.
K Guide bracket for tapering motion.
L Clearer plates.
M Steel cop box.
N Spindle rail for side winding.
O Guide plate.
P Ordinary warper's bobbin.
Q Travelling apron to remove empty bobbins.
R Steel top boxes.
S Taper or "bottle" bobbin.

In each case A is the bobbin from the ring-frame or cop from the mule; B is a brush in one case, and flannel-covered drag-board

in other cases, as shown, its use being to tension and clean the yarn.

At C or D the yarn is guided to the bobbin, while E, F or D′ are the bobbins as made ready for the warper's creel.

The spindle wharves at G, H (Fig. 15) are made larger for the back row than for the front row, and the bobbins, when perhaps one-half to three-quarters full, are transferred from front to back rows to prevent too high a winding speed of the yarn. I is the tin roller or cylinder.

Upright Spindle Winding Frame.

(Messrs. Asa Lees & Co.)

Three change wheels, F, are supplied with each frame.

The long rack is planed all over, has cut teeth, and runs on anti-friction bowls. The lifter shafts are stronger than usual, being 1-inch diameter.

When adjustable clearer plates are used a traverse motion is always provided to move the yarn up and down the slits, and thus prevent grooving the sides of the slits.

The right-hand side of the diagram shows the frame arranged for side winding with rabbeth spindles, and the left-hand side shows cop winding over the nose with a drag board and adjustable clearer plates.

Clearing Plate.

A distinctive feature of the clearing frame is the clearing plate, or other form of clearer, specially designed for clearing the yarn from snarls, neps, any kinds of impurities, bad ends, or any loose cotton. Clearers, or bad end catchers, are almost always used on an ordinary winding frame, but these are usually of a very simple, inexpensive character, such as plain steel guide plates, with sawn slits of uniform and non-adjustable size, or individual cast-iron screwed and slotted fingers. This may be quite satisfactory in the winding of single yarns from mule cops or ring bobbins to flanged warper's bobbins for the weaving trade, but they are not usually deemed good enough for the winding of two-fold yarns for the lace trade, or possibly even for fine two-fold warps. Many patents have been taken out for clearers to be used for fine two-folds, but far and away the most favourite in this country for many years past has been that known as "Suggitt's." This is usually made in portions which each serve for four threads, and each clearer consists of two plates, one of which is adjustable and the other is fixed in position.

By means of the movable piece the size of clearing aperture can be regulated and adjusted to any possible requirements, one adjust-

ment serving for four slots. The operation of unlocking each quadruple thread plate and making adjustment to any required gauge may be performed very rapidly, and after the adjustment the plate may be locked in such a manner that no person not possessing a special key can possibly alter the adjustment or size of aperture.

If a finer thread were to be cleared, or if the degree of clearing for the same thread were to be intensified, then the slots would be put nearer. Various forms of wire or needle clearers have from time to time been put into use, but serious objection to them has been their liability to become more or less charged with fluff and fibre, thus causing the threads to break unnecessarily, and not only adding to the work of the winders, but causing too much knotted yarn. The plate clearers above described are made so smooth and contain so few points upon which loose fibre or dirt will accumulate, that this feature adds distinctly to their suitability.

Unfortunately, not even Suggitt's clearer plates finely adjusted can be made to take out or impede all classes of defects in the yarns. Although they will prevent snarled yarn, neppy yarn, and bad ends from passing, they will not prevent soft places in the yarn from passing along such as might sometimes be caused by a slight over-running of a creel bobbin at the mule—a defect somewhat prevalent from the full bobbins in the top row of a mule creel. Occasional slight examples of what is termed "spewing" from the rollers may give a somewhat similar result, or very small pieces of fluff getting on the yarn, since it is well known that these thicker places resist the twist per inch, and tend to keep softer and weaker than the bulk of the yarn. Such portions of yarn may tend to draw thinner and pass through the snicking or clearer plate without breaking at the clearer frame.

The greatest difficulties in regard to cotton gassing are perhaps to be found in connection with the clearing and gassing of fine single yarns, and unless there is an expert foreman, and careful workpeople, it is necessary for tradesmen to be careful in booking orders for this sort of business if the quality is to be guaranteed.

One of the more recent forms of special clearer takes the form of a fine steel comb, mounted suitably. The comb is carried by a hinged frame, and the yarn in the usual manner on its passage from one point to another, passes through the teeth of the comb. As before stated, twenty years ago an objection found against devices containing wires or needles was the accumulation of the fly or loose fibre in the needles. In this recent device, however, the deposit of loose fibre may be conveniently removed at suitable intervals by turning the comb frame on its hinges, after which the frame resumes its working position by its own weight.

Clearing Frame.

Fig. 17 shows the adoption of a modified rabbeth self-contained spindle for the warping bobbins, with holders at M, M. Flannel-covered drag-board at D, and the flannel should be renewed at suitable intervals. Ball drag and clearing is now preferred by some. Cop holder at A may be tilted to any desired angle.

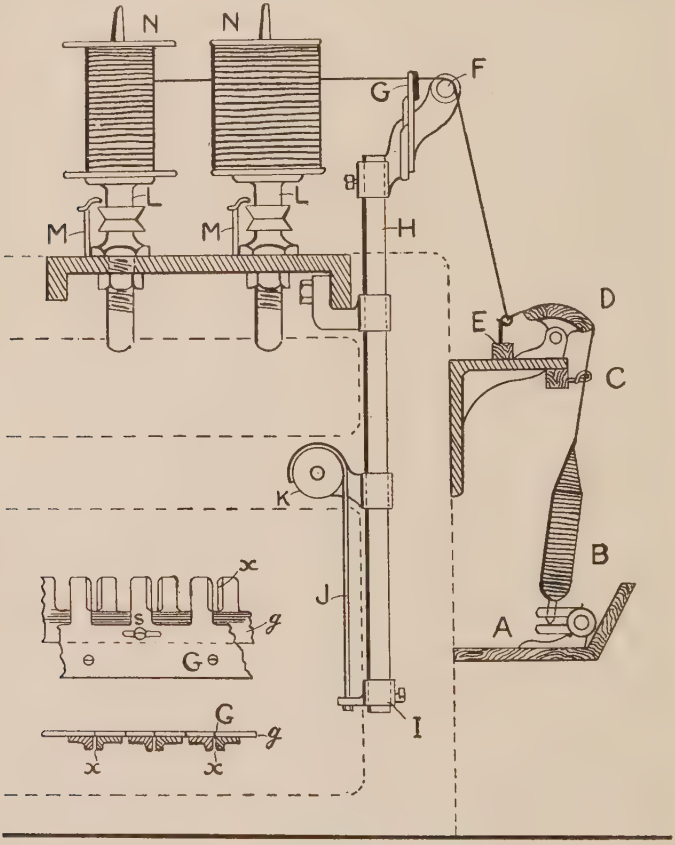

Fig. 17.

The metal clearer, separately shown at *x*, G, *g*, Fig. 17, is made up in two halves, one of which may be unfastened and moved lengthwise in order to make the clearing slits just as narrow or as wide as desired. The narrower the slits the more effective the clearing, but more likely are ends to break.

The textile trade has for very many years stood by the variable winding speed of the vertical spindle winder—broken only by transferring bobbins from front row to back row when about three-fifths full. Back row spindle wharve 1½-inch diameter, and front row 1¼-inch diameter have long been customary sizes.

Formerly, ordinary plain spindles for mule cops were almost always found on the upright spindle winding-frame for single yarns. Nowadays, it is quite common to find rabbeth revolving spindles, adapted for ring-frame bobbins, and fitted with an in and out drag-band. Small revolving tension weights are often used.

Side unwinding, nicely tensioned yarn, enhanced first spindle cost, travelling, endless aprons to carry away empty bobbins, are features of such a machine.

Bottle winding is easily obtained by any one of several motions for special application to an upright spindle winder. It is exceedingly useful for gassing frame creels, or for long lengths, such as double-double hanks, or Grant reelings. Bottle bobbins permit the usual transfer of bobbins three-fifths full from front to back row, in order to prevent an unworkably high spindle speed. Long lengths, freedom from knots, high unwinding speed over bobbin top, are merits of bottle bobbins.

Bottle bobbins are sometimes used for thread before it is balled or spooled. Two folds of 120's and finer are still sometimes preferably wound on the doubler. Three-folds, however, need too much attention to do both doubling and twisting on same machine. Using a doubling winder often enables a doubler to mind more than twice as many doubling spindles.

Waste in Winding.

Possibly due to cob-webbed ends on quick traverse cheeses; also pulling of cop bottoms is a very prolific cause of waste, especially if pasted cop bottoms are used instead of tubes. Over-filling of any cheeses or flanged bobbins may produce waste. In replacing tubes in quick traverse winding, waste results when the empty spools are not placed in exact position since webbed ends of cheeses cause yarn breakages in the next process.

Good-fitting tubes or spools are of primary importance so that they shall neither be slack nor tight in position.

Good cop bottom tubes naturally help in accurate skewering of cops, but a big lot of unskilful skewering happens with pasted cop bottoms when entrusted to careless or unskilful operatives. The attention of masters, foremen, and operatives cannot be too strongly directed to this feature.

Naturally there should be less trouble in winding and skewering from ring bobbins than mule cops.

Frequently insufficient attention is given to the question of winding frame skewers being of the same size and shape as the mule spindle blades. The winding on the mule may start too low or too high up the spindle after doffing.

Spinners may wind too softly, or put in many snarls, or hold the counter faller too much down, or start and finish the first or winding-on draws on wrong points of the tubes. When cop winders have perspiring hands there is danger of spindle rusting and difficulty in skewering.

Cop packing in skips or boxes is nearly always more or less bad for the work and productive of waste. Cop noses bent over badly, cops pressed until unfit for skewering, cops stained by weather exposure. Some doubling firms require their winders to cut knot ends or piecing ends off with scissors.

Mechanical Knotters.

The success of the Barber knotter has in the course of time led to increased attention to this kind of appliance and the introduction of other makes. Indifferently made knots have always been a source of trouble, whether made by reeler, winder or weaver, but the weaver's knot being a better one than the one known as a winder's knot, has given the lesser amount of trouble.

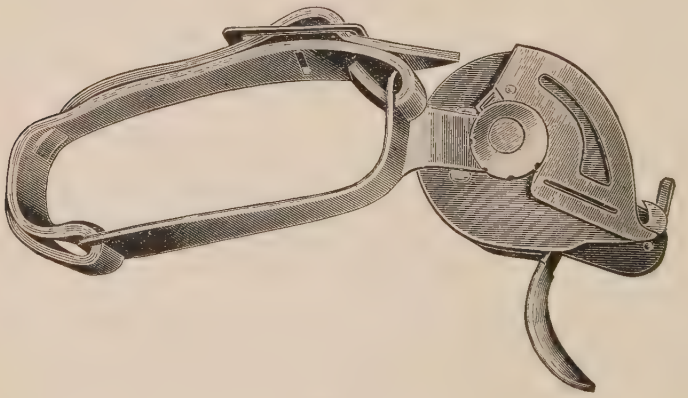

Fig. 18.

Infinitely more knots are pieced in yarn by winders than by reelers or weavers, and mechanical knotters are chiefly addressed to winders. Slack knots, long piecings, ends, dirty piecings at the winding frame invariably give trouble at a later stage.

A recently introduced mechanical knotter is described as the "liberty knotter," and consists of ten small light parts put

together in a convenient manner, and weighing less than 4 oz. complete with strap for donning upon the hand. Any part can be renewed and those which wear most quite cheaply so. The yarn ends being placed in the guide, a trigger is pressed, the yarn is held firmly by the appliance, while the knotting part rotates so as to form the knot and cut off the ends. The operation is completed, the operative releasing the trigger (see Fig. 18). (Messrs. Foxwell.) At the 1922 Manchester Exhibition several firms showed knotters.

Wages for Winding.

The war completely upset all wages rates, all costs of machinery, and costs of production. Pre-war standard or basic rates in Blackburn and Burnley ran somewhat as below.

The Blackburn list is based on fixed rates for varying weights of different counts of yarn.

Burnley upon a fixed weight of yarn for all counts.

Blackburn List.		Burnley List.	
Yarn Counts.	Lb. for 1s.	Yarn Counts.	Price Per 60 lb.
			s. d.
18's	55	18's	1 3
20's	52	20's	1 4¾
30's	38	24's-26's	1 5¾
32's	36	32's-34's	1 8
34's	34½	36's-38's	1 9½
38's	32	40's-42's	1 11
40's	31	44's-48's	2 0½
46's	27½	50's-52's	2 2
50's	26	54's-58's	2 3½
60's	22	60's-62's	2 5
70's	19		
80's	16½		

Clearers.

There are many forms of winding frame metal yarn clearers, but Suggitt's has been a great favourite in the doubling trade since 1890 or earlier. It is made or supplied by almost any maker of winding frames, being adopted very soon by such eminent firms as Messrs. Slubb's of Manchester. Fig. 17 shows this clearer at the lower left-hand.

Usually made in plates of four slits each, so that one adjustment opens or closes four slits at once. Mostly attached to the traverse rails of winding frames to clear knots or other faults out of the yarns.

Single slit yarn clearers may be obtained, either adjustable or non-adjustable. These clearers may be provided with locks to prevent unauthorised persons from altering the settings.

Highly polished metal balls or glass balls sustained in special bearings, and having the yarn guided beneath them, have been applied to many winding frames since about 1912. They tension the yarn very nicely and do a certain amount of clearing.

There may be a ball, suitable thread guides, and a pot cup for each ball. Usually a V-shaped bearing for the ball with open bottom to permit any dirt, leaf or fibre to drop out. Balls regulated in size and weight to suit kind and counts of yarn. The cups are fitted in a special rail used instead of the flannel-covered dragboard, or instead they are fitted on the traverse rail. The ball rolls in obedience to the yarn pull and this is good for retaining the freedom of the fibres. In tensioning, clearing without taking nap off the yarn, chances for fluff and dirt to get away from the yarn, adaptability to varied conditions, these rolling glass or metal balls, have proved suitable for many users of winding frames.

A common diameter of tin roller for an upright spindle winding frame is 5 inches: of tinned steel preferably on short lengths. Coupled up, balanced, and tested at higher than working speeds before leaving makers. Good bearings, easily lubricated, are advisable for tin rollers, and steady running tin rollers are important for quietness and good results. 600 r.p.m. for back row of spindles and 800 for front row, are approximate speeds.

Building motions for upright spindle winders may be either on the cam or mangle-wheel principle, the last-named being now the more popular. Winding frames with single rows of bobbins—instead of the usual two rows—and spindles driven at a differential speed have been used to some extent, the bobbins revolving slower as their diameters increase. Single row, ordinary winding frames may be used for hank winding.

Either parallel or barrel shaped bobbins may be obtained from either the cam or the mangle wheel traverse. The barrel bobbin enables more yarn to be put on a bobbin without increasing the diameter of bobbin flanges. This barrel shape is a very old arrangement.

Revolving ring-bobbins in the creel with side unwinding, may take 150 r.p.m. for tin roller, and end unwinding reach up to 180 r.p.m. A good length of frame may have 350 spindles, single yarns.

For single warp yarn 20's to 30's or so, a good winder may attend up to 55 spindles and produce fully 800 lb. per week of forty-eight hours on 20's or 540 lb. of 32's, end unwinding. Possibly two-thirds of this latter productions for 60's/2, end unwinding, or 360 lb. from revolving ring bobbins.

Cop skewers and creel pegs should be adapted to requirements of each case. Brushes are much used for single yarn clearing.

Upright Spindle Winding Frame (Fig. 19).

Messrs. Brooks & Doxey.

"*Maker's Remarks.*—The frames are made 5 feet 6 inches wide. We do not recommend the frames being made more than 44 feet long when driven at one end.

"To ascertain the length of the frame overall, multiply the gauge by one quarter the number of spindles and add for gearing 20 inches for $2\frac{1}{2}$-inch pulley, $2\frac{1}{4}$-inch belt; 21 inches for 3-inch pulley, $2\frac{3}{4}$-inch belt. If with travelling apron add 31 inches.

"Standard gauges are—

Gauge.	Lift.	Dia. of Full Bobbin.	Details of Winding-on Bobbin.			
			Dia. of Head.	Length Overall.	Dia. of Hole.	Dia. of Spindle-blade.
ins.	ins.	ins.	ins.	ins.	in.	in.
4	4	3	3	$4\frac{3}{4}$	$\frac{3}{64}$	$\frac{11}{32}$
$4\frac{1}{2}$	$4\frac{1}{2}$ or 5	$3\frac{1}{2}$	$3\frac{1}{2}$	$5\frac{1}{4}$	$\frac{23}{64}$	$\frac{11}{32}$
5	5	4	4	$5\frac{3}{4}$	$\frac{23}{64}$	$\frac{11}{32}$

If barrelled add $\frac{1}{2}$ inch to the above diameters of full bobbin.

"If standard bobbin is not adopted, send a sample of the winding-on bobbin, so that our spindle blade can be made to suit.

"The bottle bobbin is recommended when the yarn has to be wound at a quick rate from the end as in gassing and reeling.

"We recommend the "upright" winding-on spindles being self-contained. This admits of a much higher speed being attained if required, it saves power and does away with the necessity of constant oiling. The spindles usually run twist way. The front row of spindles are made with $1\frac{1}{4}$-inch diameter wharves, the back row with $1\frac{1}{2}$-inch wharves, so as to run slower, as it is customary to transfer the winders bobbins, when about half full, from the front to the back row. The spindles are arranged in single rows when winding from hanks.

"When winding from double-headed bobbins or any revolving bobbins, we recommend self-contained revolving spindles being used in single or double rows, according to the size of the bobbin head.

"If stationary peg is required state diameter and length of peg on plain part where the bobbin has to revolve.

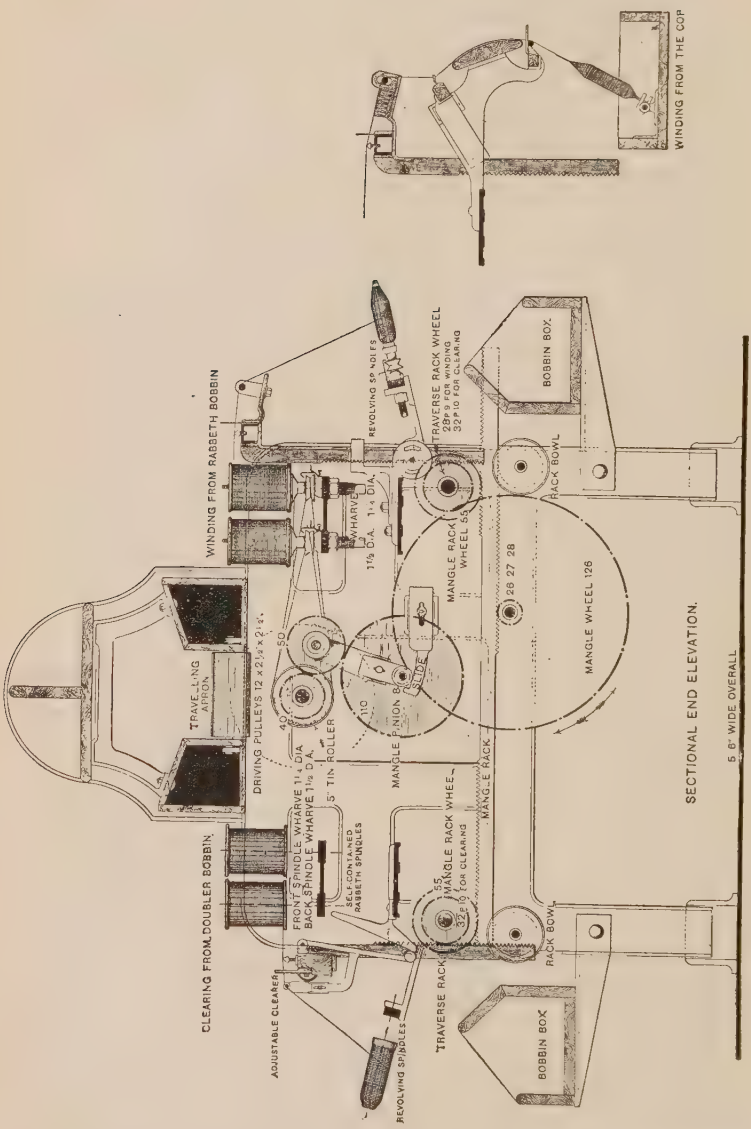

FIG. 19.

"If a cop reel is required send a sample of the skewer being used, so that our iron skewer brackets can be furnished to suit

the foot of the skewer. If our standard steel skewer is ordered, it is suitable for a cop 8 inch-overall, and our standard split wood plugs are suitable for the usual 5 or 6-inch lift ring-frame bobbin, but if these wood plugs are ordered with us, it is advisable for a sample bobbin to be sent.

"We supply steel plates with slits in, but for special yarns and for all fine doubled yarns we strongly recommend our improved adjustable cast iron clearers, adjustable every four nicks, and provided with guards to prevent the work-hands tampering with the adjusting screws.

"We recommend brushes being adopted for all single yarns, and advise their being spaced.

"*Gigging.*—This motion is an advantage for winding off the yarn remaining at the bottom of the cop.

"It is advisable to send a cop skewer or creel bobbin, so that the holes in the creel brackets can be made suitable, if winding from cops, or the blade of the spindle if winding from self-contained revolving spindles.

"We supply a pulley 12-inch diameter, $2\frac{1}{2}$-inch wide, $2\frac{1}{2}$-inch belt, for all frames up to 350 spindles, and advise a pulley 12-inch diameter, 3-inch wide, $2\frac{3}{4}$-inch belt, for all frames above 350 spindles, to run at 150 r.p.m., which gives 600 revolutions on upright spindle with $1\frac{1}{4}$-inch wharve when winding off revolving bobbins, or 200 revolutions of this pulley which gives 800 revolutions on spindle for cop winding, or off end of ring bobbins.

"The usual allowance of two spare change lifter wheels, supplied without extra charge."

Winding.

Machines such as the ordinary pirn winder, or any type of winder which is fitted with a cop-building motion, may be used to advantage in re-winding damaged or other cops, and making them suitable for the shuttle.

Cop-making winding frames of one type or another can be built or adapted to build any size of cop required—from the small cops of $4\frac{1}{2} \times \frac{7}{8}$-inch diameter for some of the thinner and finer cloths, to cops of 4 inches diameter × 12 inches length used for feeding knitting machines, or cops of 8 inches length × $1\frac{1}{2}$-inch diameter required for the shuttles in weaving sponge cloths. In one case the writer saw cops of $1\frac{1}{2}$-inch diameter × 20 inches length, built upon a specially arranged pirn or jumbo winder for use as weft in an experimental circular loom.

Such re-wound cops are tightly wound and contain the maximum length of yarn for any given dimensions, and are suitable for various processes requiring a large supply of yarn at regular tension,

and given the minimum amount of waste. The quick traverse of the jumbo and other types of winder, is especially suitable for giving rapid crossings of yarn which enable cops to wind off without ever getting halched noses, and will also in some cases wind off externally over the conical nose or internally from the base of the cop. For the heavier winds and cops bevel wheels are sometimes used for the spindles.

Smaller and more ordinary pirn winders have spindle band driving from tin rollers 6 inches diameter, spindle wharves 1¼-inch diameter, 12 × 2½ inches pulleys, per spindle per hour, 120 spindles per i.h.p.

Bottle Bobbins.

About 1900 the present writer was able to state from personal investigation that the recently introduced tapered bobbins were already proving extremely useful for gassing frames, since they were unwound from the ends, would hold as much yarn as several cops, and speed is then only limited by the cam motion. Improvement has proceeded rapidly in cotton gassing, while the use of the split drum has afforded a means of overcoming the violent impact of the end cam due to high speeds and a common traverse bar. It was soon found that bottle bobbins would hold as much yarn as half a dozen cops or more, and especially when bastard cops were in use; and all along the use of cops has been rapidly superceded in this particular connection, the same remark applying to ordinary warper's bobbins. Speeds of 7-inch drums went up from 110 or so revolutions per minute to 220 or more, while the speeds now claimed for the latest gassing frames with vertical lights, cross-wound gassed spools, split drums, tapered bobbins, intensified pressure, mixed air and gas, and patent ventilators, appear almost incredible—reaching 800 or so revolutions per minute for some sorts of work, according to the claims of makers.

Tapering Motion.

The introduction of tapered bobbins alone has sometimes been responsible for a very considerable saving in the expense of gassing since so much has been saved in piecing up, reduced amount of creeling that an attendant using bottle bobbins, and winding the gassed yarn upon cross-wound spools without flanges has been subjected to a reduction of possibly 50 per cent., and yet has earned distinctly more wages than when winding from twiner cops and using flanged bobbins for the gassed yarn. The end unwinding is also much better suited for soft and fine yarns than is the side un-

winding from double flanged warper's bobbins as formed at the clearing frame. There are several arrangements in use for building bottle or taper bobbins.

How the Bobbin is Built.

In building the ordinary warper's bobbin without the barrel-shaped effect, there may be used either a heart-shaped cam or a mangle-wheel motion, and there are many variations in detail of connected mechanism by different makers. Taking an ordinary mangle-wheel motion a small wheel fixed on the shaft of the tin roller may drive through a small carrier, a very large stud wheel, and on the same stud or short shaft is fitted a very small pinion which gears into and drives the large mangle wheel. It need hardly be stated here that this mangle wheel is built with open peg or pin teeth, so that the driving pinion may gear either on the inside or the outside of the mangle wheel, thus converting the latter alternately into an external and an internal wheel. The second, third, and fourth wheels are sustained in an arm which is suspended loosely from the shaft of the tin roller, and is thus capable of swinging slightly so as to permit of the natural movement of the mangle-wheel pinion from inside to outside of mangle wheel, and vice versa.

For the purposes of making the bottle bobbin an extra attachment is made to the ordinary mangle wheel mechanism by which the yarn is lifted in varying degrees higher than the maximum lift given by the mangle wheel. The traverse is permitted to remove at a uniform rate at the lower portion of the traverse, and therefore a parallel length of bobbin is built at the point. Each traverse extends to the bottom of the bobbin, but only a limited number of traverses ever reach the top of the bobbin, the number of traverses which reach the tapered portions of the bobbin increasing at any positions downwards. For example, the first layer may cover only about the parallel portion, while the next layer will extend a little higher, so as to overlap and bend in the end of the first layer. In this way each succeeding layer will wind a trifle higher than the last one, until the maximum length has been attained, when the cycle of operations and varying heights of lift from minimum to maximum will be repeated; and so on until the bobbins are sufficiently large. A little reflection will show that this system of winding and traversing will form a kind of top cone on the bobbin, while at the same time locking the different layers so as to prevent ridging and to ensure the yarn coming off in a suitable manner without ravelling.

Such a bobbin is perhaps never side unwound, and everything is done with a view to obtaining the most satisfactory end unwinding. The top of the empty bobbin may either be quite plain, or better still

may have a slightly rounded head, which does not interfere with end unwinding. Such a bobbin may be from $3\frac{1}{4}$ to $4\frac{1}{4}$ inches diameter, $6\frac{1}{2}$ inch lift, and may contain from $\frac{3}{4}$ lb. to $1\frac{1}{2}$ lb. of yarn, according to any particular requirements. It is a very easy matter to disconnect the tapering motion so as to permit the ordinary parallel warper's bobbins to be made, if this were ever required.

Tapering Motion for Winding Frames.

The object of this motion is to wind a bobbin which will hold a very large supply of yarn and which can be unwound over the

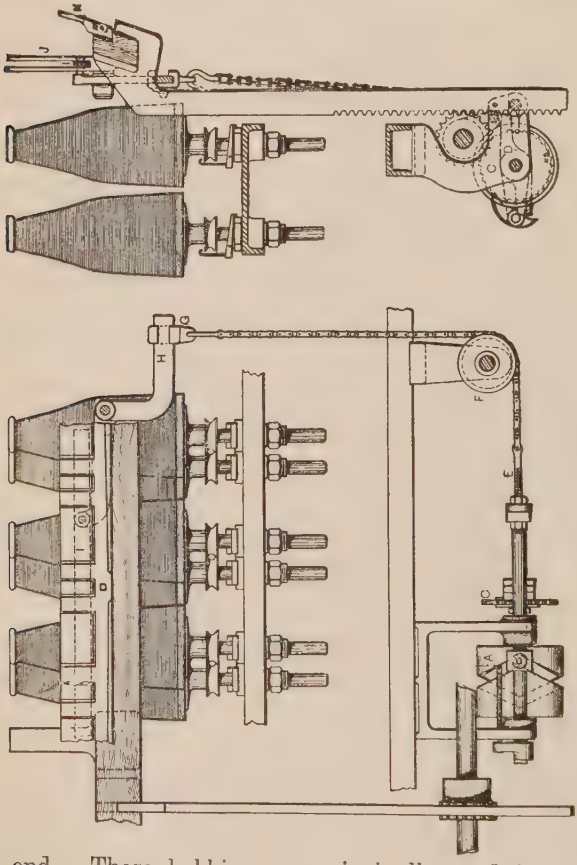

FIG. 20.

References to Diagram.

A Cam drum.
B Finger for do.
C Ratchet wheel.
D Feed lever.
E Adjusting screw.
F Guide pulley for chain.
G Adjustable clip bracket.
H Rocking lever.
I Lifting bar.
J Guide bracket for do.
K Clearer plate.

end. These bobbins are principally used for supplying gassing frames.

In winding, the ordinary guide rail moves at a constant speed for about 4 inches of the lift, and then the auxiliary rail, or lifting bar I, comes into operation, moving at an increased speed, and thus laying the yarn on the upper part of the bobbin in a coarse spiral.

The amount of traverse of the lifting bar is constantly varied by the movement of the cam drum, A, which is rotated by the ratchet wheel, C, thus shortening or lengthening the lift and producing the taper formation of the bobbin.

By simply unhooking the chain at G, the motion is entirely disconnected, and an ordinary parallel bobbin can be made.

Different arrangements by different makers.

Doubling Winding Machine.

A doubling winding frame may be a single drum machine or a double drum machine, and may have a quick traverse or a slow traverse. In the latter flange bobbins are used, but in the quick traverse drum winding machine the "cheeses" are formed upon a spool without flanges to keep the edges good. In this machine the cops or ring bobbins are placed in a creel at the front and lower part of the machine. The threads are conducted through guide holes over an adjustable, flannel-covered drag-board, through detector wires, upwards over a small wooden guide roller, and downwards again, when two or more threads are wound together on the same bobbin. Each thread passes through a separate detector wire, and when the thread breaks the wire falls and sets in motion mechanism by which the particular bobbin upon which the broken thread was passing is swivelled out of contact with the driving drum. Simultaneously a brake is brought against the cheese, causing instantaneous stoppage of the bobbin, and preventing "single" from passing thereon. In this facility for preventing "single," combined with a like prevention of "cork-screwed" yarn, lies the great merit of this process. By "cork-screwed" yarn is meant the twisting and doubling together of threads of uneven tension, whereby the slack thread becomes in a manner coiled round the tight thread, and the latter has to sustain all the strain. "Cork-screwed" yarn is of no use when it is used for thread which has to pass through the eye of a needle.

Occasionally in fancy doubling, a cork-screwed effect is purposely obtained. By giving a very rapid horizontal traverse to the threads in a quick traverse drum winding frame the yarn is cross wound upon the cheeses in exceedingly open coils, and this causes the cheeses to be very solidly and firmly built up. Also the threads dwell such a small time at the edges of the cheeses that flanged bobbins can be dispensed with, which is a great advantage for transit purposes.

Fig. 21 is a diagrammatic view of a well-known make of doubling winding frame, using flanged bobbins, M, driven by

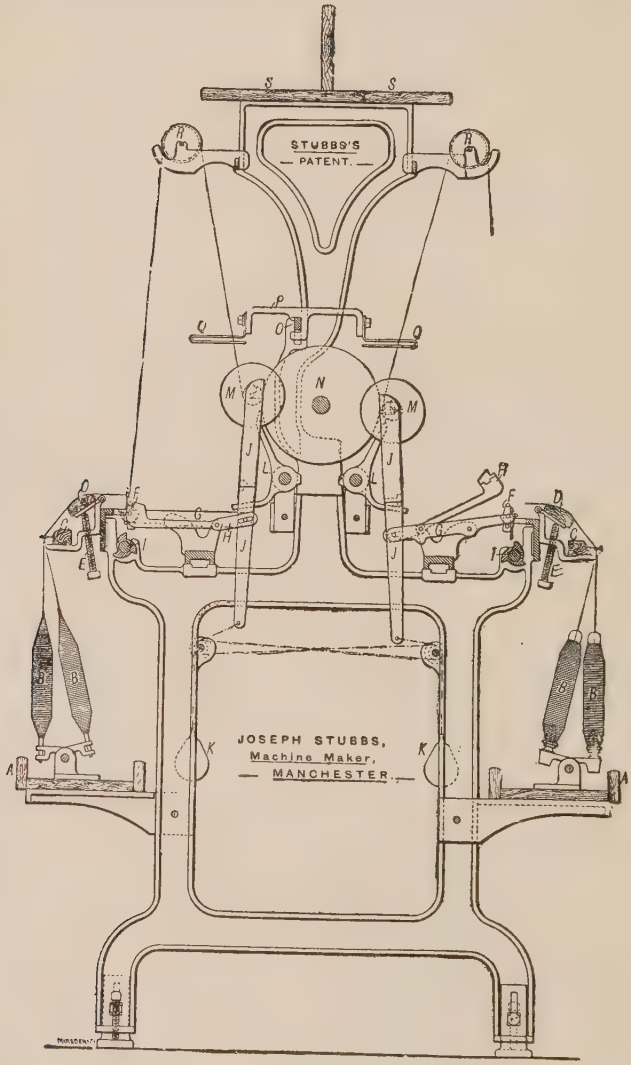

FIG. 21.

frictional contact with the drum, N. It is a single drum winding frame, slow traverse, and has been much improved.

Quick Traverse Winding Frame, Double Drum.

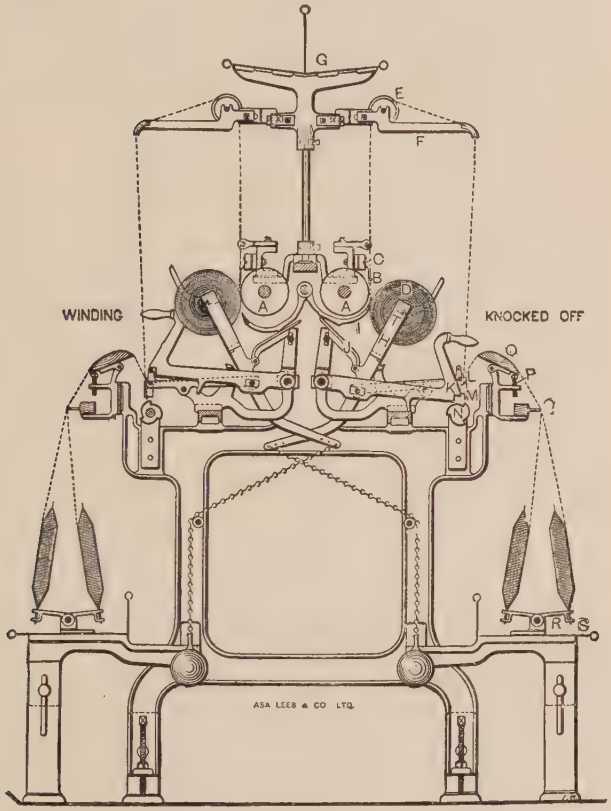

FIG. 22.

References to Diagram.

A Winding drums, $3\frac{3}{4}$ inches diameter.
B Steel traverse guide with porcelain thread guide.
C Steel traverse rod.
D Spool.
E Guide pulley.
F Tension bracket.
G Steel bobbin box.
H Mandril cradle.
I Movable brake.
J Incline to lift brake.
K Starting lever.
L Detector pin box.
M Detector pin.
N Revolving wiper.
O Drag board.
P Adjusting screw for drag board.
Q Thread wire rail.
R Skewer bracket.
S Steel cop box.
T Steel bearing for mandril ends.

Length of Winding Frames.

Slow Traverse Winder 5″ Traverse, 7″ Gauge No. of Drums × 7″ + 2′ 4″ 2 Bobbins per Drum.		Quick Traverse Winder 5″ Traverse, 7″ Gauge ½ No. of Drums × 7″ + 3′ 7¾″.	
Bobbins.	Length.	Drums.	Length.
40	14′ 0″	40	15′ 3¾″
50	16′ 11″	50	18′ 2¾′
60	19′ 10″	60	21′ 1¾″
70	22′ 9″	70	24′ 0¾″
80	25′ 8″	80	26′ 11¾″
90	28′ 7″	90	29′ 10¾″
100	31′ 6″	100	32′ 9¾″
110	34′ 5″	110	35′ 8¾″
120	37′ 4″	120	38′ 7¾″
130	40′ 3″	130	41′ 6¾″
140	43′ 2″	140	44′ 5¾″
Width of frame, 3′ 9″.		Width of frame, 3′ 7½″.	

Doubling Winding.

In the doubling winding frame it is now the more common practice to have a quick traverse, and to use spools or bobbins without flanges. These quick traverse drum winding frames are now largely used to prepare the yarn for the doubling frame. The usual mode of procedure on these machines is to place the mule cops or ring-frame bobbins—or possibly hanks of yarn in a suitable creel. Each end is drawn upwards through a guide wire, over a flannel-covered drag-board, and then through the eye of a needle which forms part of the detector wire stop-motion. Leaving the detector wires from two to six threads may be collected together into one thicker thread, and the loose rope of threads thus formed pass through a guide aperture, and upon the bobbin. Assuming, for example, that three threads were being wound together, if any one of the three were to break or fail from any cause the suspended detector wire would drop into the path of a small revolving wing-heater shaft, which would move the wire into a fresh position, thus rocking the needle box and freeing a brake, which would at once stop that particular cheese or bobbin upon which the threads were passing. The use of a quick traverse obviates the necessity for using flanges on the bobbins, as the threads are thereby taken very quickly from the edges of the bobbins. In a great many cases it is

found that a nicer thread can be obtained by using the winding frame, although it is quite feasible to do both doubling and twisting at the twisting machine. The use of the winding frame fitted with an effective stop-motion enables "corkscrewed" and "single" yarns to be almost eliminated, and these two defects have often been very troublesome in doubled yarn.

Winding of Waste Spun Yarns.

A drum winder is good for this kind of yarn. Yarns spun from one kind or another of cotton waste are used for an infinitely large variety of purposes. A great amount of the yarns spun from the lowest classes of waste are used for such purposes as sponge or cleaning cloths, and for lamp-wick. Better sorts are used extensively in the manufacture of woven goods, of which cotton blankets and cotton rugs are typical. Cotton trouserings for outdoor or indoor wear in certain countries are largely made from cotton waste yarns. If we take the softer and better sorts of mule waste—excluding bobbin waste and cop waste—and taking top and bottom clearer waste as the main example, it might be suitable for making possibly about 10's counts of yarn, and a little higher still if mixed with a proportion of better fibre.

Humidifying.

Generally speaking, and all circumstances considered, we might say that from 50 to about 58 per cent. of relative humidity would probably be found to be best. Humidity in a proper proportion is undoubtedly of great benefit in the processes of cotton treatment, but many people consider that for the greater part of the year in England there is sufficient natural humidity in the atmosphere. In the spinning of fine counts greater attention is usually bestowed upon matters which incidentally affect the problem of practical cotton spinning, and for years there has been a growing tendency to apply one or other make of artificial humidifier. The need for these is more especially felt in periods when dry, east winds prevail, or cold, dry frosts, or dry hot summer days. On such occasions the cotton fibre is liable to become curly and less liable to yield properly to the processes, and is also extremely susceptible to the effects of atmospherical electricity, as created by the driving belts and the revolution of many working parts. Cotton winds, spins, and weaves best in a warm, moist atmosphere, and a due proportion of moisture in the atmosphere helps the latter to absorb the generated electricity in a much better manner than a dry atmosphere can do.

Drag.—Very discursive treatment could be easily given on drag in winding and clearing frames.

Various methods applied by makers, but usually specified as extras if not flannel.

It may be contended that no other method yet is so versatile as flannel drag-board which can be put to give more or less drag or clearing readily from a common centre, whereas other methods give much work to foremen in changing.

Ball drag is better with lighter balls for lighter work, but it is generally agreed 20 counts would stand good. It has been said that balls put in for 40's could be used for 20's and 60's = 40 range. Some firms prefer flat circular revolving weights.

Some mills have filled their mills with ball drag.

Some balls could be lifted to a higher position to give less drag.

One firm are experimenting with rollers definitely revolved, flannel or leather covered for drag. Pot drags may require changing for much different counts of yarn.

Flannel always gathers fly, and in this way gives some bad ends.

Pirn Winding Frame.

This machine is for winding cross-wound cops or pirns on the bare spindle or on paper tubes. It can be arranged to wind all kinds of yarn from hanks, cheeses, cops or bobbins, and will make a cop or pirn which will weave from the inside or the outside. As the cops are cross-wound on the bare spindle or on thin paper tubes a maximum supply of yarn is secured, and all the available space in the shuttle is filled. Owing to the method of cross-winding, the cops cannot be injured by crushing or rough handling, can always be skewered, and will weave off to the last inch without waste.

A separate yarn guide is provided for each spindle, and each guide is worked by a separate eccentric instead of all the guides on one side of the frame being worked from the same eccentric as in other makes of pirn winding frames. Where only one eccentric is used the speed is limited, but with the patent method just described a very great increase in speed is secured.

Ball bearings can be supplied for the spindles if desired.

The production of the ordinary type of pirn winder averages about two hanks per spindle per hour, but with this patent winder a production of about 10 hanks per spindle per hour can be obtained.

The diameter of the cops or pirns can be quickly altered to suit different sizes of shuttles.

When weaving from cops produced on this frame the tension of the yarn remains practically constant from the beginning of the cops to the end.

Winding or Clearing in the Doubling Trade.

Winding is usually the first machine process in a doubling mill. Winding should help to reduce the evil of uneven tension in doubling, and the resultant thread should be as free as possible from corkscrewed and single yarns, knots and uneven places. Whether the winding is done from revolving ring bobbins, or over the ends of such bobbins or from cops, uneven tension and corkscrewing must always be guarded against by using suitable tensioning brushes, plates, guide rods, flannel-covered boards, or other means.

Strength is very important in some cases, such as for sewing threads, and the modern practice of winding two or three ends together on the doubling winding frame before twisting, is good for some purposes but not always best for strength.

For example, in making two or three cord sewing thread some prefer to have single thread winding upon double flanged bobbins in order to get long lengths of yarn on one package, and then do both doubling and twisting on the same machine.

For cabled 4-cord or 6-cord it is a common method to wind the single yarn into 2-cord at the doubling winder, twist on the doubler and then wind and twist two or three of these 2-cords together.

The lower surface speed of the doubling frame bobbin, compared with the surface speed of some doubling winders, diminishes the danger of uneven threads, and hence gives a stronger average resultant.

Some doubling firms have occasionally given up using two and three end winding together because of supposed loss of strength due to uneven tension.

In cone winding on drum winders there is a reduced winding speed on the small end, and this makes wider spirals and consequently softer cone ends because the traverse speed is the same all the time. The speed variation will depend primarily upon the degree of taper, but may be from 20 to 30 per cent. The cones are very suitable for end unwinding in twiner doublers and in reeling. For gassing frames the bottle-shaped bobbin from the modified spindle winder is mostly preferred.

Double cones on bobbins—as per the roving frame—also favour end unwinding in some degree.

Cheeses of either single or doubled yarn, 5 or 6 inches wide × 7 to 9 inches diameter, wound on paper tubes, are suitable for export and transit purposes.

It is possible to wind two small separate cheeses on one spindle, but there is little use for this.

In a single drum winder each drum drives two bobbins or cheeses—one on either side, the yarn passing "outside" on one cheese, and "inside" on the other cheese.

The single drums may be 7 inches diameter running down the centre of the frame, against 3 inches diameter for the double drums —one line of drums on each side of the machine, one cheese or bobbin for one drum.

Occasionally, winding frames are constructed to wind from reeled hanks. Often such frames have slow traverse, flanged bobbins, and are very suitable for winding yarn that has been bleached or dyed in the hank form.

Metal clearing plates or guides are commonly used on vertical spindle winders, and in some cases a movable rod has been extended the length of the frame under the threads to prevent wear in the guide slits. Such rods must not be permitted to interfere with the build of the bobbin.

Two Calculations.

1. Supposing you have some yarn bobbins of 18 and 30 hanks, and you want to use them up—one of each working together—what would be the resultant counts?

There are various methods of working such calculation as this one, each of them being simple, and the calculation being quickly worked. One method used in finding the resultant counts when two yarns or rovings of unequal counts are doubled together is to "divide their product by their sum." Example :—

$$\frac{18 \times 30}{18 + 30} = 11\tfrac{1}{4} \text{ resultant counts.}$$

This hank would be equal to doubling two $22\frac{1}{2}$ counts together.

2. A mill produces 2,750 lb. of 40's, 4,000 lb. of 56's, 3,500 lb. of 60's, and 5,000 lb. of 80's, what would be the average counts?

This calculation depends primarily upon the fact that hanks divided by counts gives lb., or hanks divided by lb. gives counts. The method required is to reduce all the weights to hanks and then divide the total hanks by the total weight in order to obtain counts.

	2,750 lb. × 40	= 110,000	hanks of 40's.
	3,500 lb. × 60	= 210,000	,, 60's.
	5,000 lb. × 80	= 400,000	,, 80's.
	4,000 lb. × 56	= 224,000	,, 56's.
Total	15,250 lb.	944,000	total hanks.

$$944{,}000 \div 15{,}250 = 61{\cdot}7.$$

Effect of Reverse Twist in Doubling.

The chief effect produced on the single thread by the doubling twist, is that when twisted or doubled the same way as spun each single yarn retains its full spinning twist at least, besides participating in the doubling twist as a component part thereof; whereas when the doubling twist is put in the opposite direction each doubling twist takes one twist out of each single yarn. When twisted in the same way the two-fold thread is darker and altogether more intractable unless fixed in some way, whereas with the opposite twisting the tendency for untwisting in the single thread is balanced by that of the doubled twist, so as to produce a permanent set, so that this opposite twisting is common for two-folds for warp and lace purposes. The same way of twisting is in extensive adoption when the two-folds have to be made into four-folds or six-folds for the purposes of sewing thread in which the second doubling twist is in the opposite direction, and this method gives a strong concentrated sewing thread. The single threads often receive the opposite twisting when intended for re-doubling for the fuller but possibly more polished crocheting cottons. Amount of thread tension greatly affects yarn "setting."

If only one doubling and twisting be resorted to the same direction of doubling twist will give a more concentrated and possibly a stronger thread, but a more unruly one to handle.

Ratio of Winding and Traverse Speeds.

Softness or hardness of bobbin or cheese of yarn, webbing or running off at the ends of the bobbin, quantity of yarn put on the bobbin or cheese, counts of yarn, number of doublings or folds, and length of spool, are the chief factors in determining the relative speeds of winding-on and traversing of the yarn. The lateral traverse should be sufficiently quick to limit or prevent webbing or running off at the ends of the bobbin, and prevalence of this evil would be a reason for speeding up the traverse in relation to the drum. On the other hand, the traverse too great in proportion to winding-on, we might produce the evil of soft bobbins or cheeses, and insufficient length of yarn wound on each full bobbin. With split drum winders it might be necessary

Slow Traverse Drum Winder.

For certain sections of the cotton trade this has been in use for very many years for single end winding instead of using the single end vertical spindle winder.

In the case, for example, of yarn that has been bleached and dyed in the hank the drum winder has proved very suitable

for putting such yarn upon flanged warper's bobbins. The "latch and catch" motion was a term applied to an arrangement on such frames for latching a bobbin up while piecing a broken end.

In the same way the slow traverse drum winder may be adapted and used as a doubling winding frame for winding together two or more threads from mule cops, ring bobbins, or other bobbins, upon double flanged bobbins ready for the creel of the doubling or twisting frame. Such a doubling winder may be more solidly and strongly built than a vertical spindle single end winder, and may contain a single row of drums 7 inches diameter, running down the centre of the frame and each drum driving two flanged bobbins or one on each side. Machine-cut gearing from solid blanks, well guarded, and ruled in speed only by the skill of the operatives and the quality of the yarn.

Although the main cam of the traverse motion runs rather slowly, as required for the slow traverse, it may be placed inside a box forming an oil bath, giving a smooth, quiet, efficient action and a well-built bobbin.

Although the quick traverse drum winder has gained in use and been extended in its scope of usefulness and application, there yet remains a place for the slow traverse drum winder.

When adapted and used as a doubling winder the stop-motion for broken ends is usually on the detector wire principle, and good machine makers have improved the construction and action of these motions of recent years to increase their solidity, rigidity, and promptness of operation. The brake in some cases is set very close to the empty bobbin, and as the bobbin fills the brake recedes so as to leave the same small clearance of brake and bobbin for all diameters. A fixed brake needs adjustment to be clear from the full bobbin and may be too far from the empty one. In some good makes when an end breaks and the bobbin drops, the brake rises to meet the bobbin, ensuring quicker effect due to the double action.

Really prompt action of the stop-motion prevents the broken loose ends from winding-on the bobbins even at high winding speeds.

For their slow traverse doubling drum winder one firm states:—

"A girl will mind 20 to 30 spindles, according to counts and number of ends to each bobbin; 1½ to 2 h.p. for 120 bobbins. Also a speed of 200 r.p.m., for the pulleys, and a winding speed of 120 yards per minute."

It may be here noted that traverse rods for drum winders have been very generally reduced in diameter during recent years, with the benefit of easing the blow and giving much easier reversing at the ends of the cheeses or bobbins. In some cases a light steel rod of square section is used, and in other cases a special rolled

mild steel rod. Either example permits firm fastening of the well-finished steel wire thread guides.

Creels to permit yarn unwinding over the top or end for ring bobbins and mule cops, or for side unwinding from live spindles, fixed pegs, or from hanks.

The slow traverse drum winder has been superceded by the quick traverse for most doubling winding, but still has some vogue for doubling winding.

It may be used for winding two or more threads from cops, ring bobbins or hanks, on two double flanged winding bobbins preparatory to twisting on the doubling frame.

An instantaneous knocking-off motion is provided for each end, and in modern frames is so sensitive that it quite prevents over-running and consequent waste. The bobbin spindles may run in special steel bearings which are replaceable when worn, and in this way the spindles are not so liable to wear on the pivots.

The slow traverse of drum winder may be obtained by one of the arrangements of the well-known mangle-wheel motion, which has proved itself simple and efficient on thousands of winding frames. In some cases the bearings for the drums are bushed with brass and all the spur wheels are cut from the solid. Bobbin and cop boxes of good wood or of sheet steel as required. A common gauge is 7 inches and a common traverse is 5 inches, bobbin flanges 4 inches diameter.

Driving pulleys 10 × 2½ inches with a speed of about 250 r.p.m. Drums 7 inches diameter. 120 drums per i.h.p.

For some kinds of work doubling and twisting are still both done on the twisting machine, but even in those cases it is quite common to wind the yarn singly upon warper's bobbins before going to the twisting frame. Strong yarns which seldom break are most likely to work in this manner, but even then the difficulty and want of an efficient economical stop-motion for breakage of single ends is often experienced.

Quick Traverse Winder.

The quick traverse doubling winding frame has firmly established it as a desirable machine for most classes of work in which two or more ends are doubled and twisted together; and possesses advantages as follows :—

(*a*) Corkscrewed yarn is vastly reduced in quantity.
(*b*) "Single" is nearly eliminated.
(*c*) It is easy to apply and operate a single-thread stop-motion.
(*d*) The quality of work from the twister is enhanced.
(*e*) The work of the doubler is very greatly reduced.
(*f*) The twisting frame creel is simplified.
(*g*) Paper tubes may be used, or else wood bobbins or tubes

without flanges, which are cheaper in both first cost and in renewals, and are better for transit. Paper tubes are especially convenient for shipment.

(*h*) It is quite easy to alter a doubling winder from parallel to conical cheeses, suitable for twiner or hosiery creels, and very suitable for end unwinding.

A doubling winder not only transfers yarn from one form of package to another, but also winds two or more single ends together; and has the distinctive feature of a detector wire stop-motion for each single end, and to stop the one cheese only. The stop-motion always removes the cheese from drum contact instantaneously, and always has pick-up devices for re-pieced threads.

Usually there is a brake to stop a cheese promptly, and also each thread is taken round a light over-head pulley to give plenty of piecing-up yarn, and prevent a broken end disappearing upon the cheese or bobbin.

A doubling winder mostly has its creel fitted for mule cops or for ring bobbins, in each case for end unwinding, wooden pegs being used for ring bobbins and suitable spindles for mule cops.

Many differences in detail exist in different makes, but the following are essential features:—

1. A suitable and very accessible creel for single yarn.
2. Suitable flannel-covered drag-board and yarn guides.
3. A detector wire or hairpin for each single thread, with a revolving "wiper" or star wheel shaft revolving below the detector wires.
4. A cradle lever holder which contains the cheese, holds it firmly against the drum when working, and capable of promptly leaving contact with the drum when an end breaks.
5. Either a single line of drums centrally disposed, or else two lines of smaller diameter of drums.
6. A traverse motion which is often the most complicated part of the mechanism.

Thread wires are used to keep each thread under sufficient control. Drag-boards may be inclined as required.

Adjustments are provided to keep the cheese parallel to the drums. Weighted levers and chains to maintain cheese in contact with drum.

Cams to revolve in oil baths. Traverse wires as light as possible, now often of about 6's wire or an equivalent square section.

Detector wires may be of any weight to suit the strength and counts of yarn in use and may be easily changed.

Notes on Winding.

Cop skewers should always be a genuinely good fit for the cop apertures, and always a good fit in the creel brackets.

Roller cloth is very suitable for the drag-boards.

Cop skewers should have their holders set so that the yarn will pull straight, equally, and easily over the apieces of cop and spindle.

A reasonable distance from spindle point to first guide helps yarn to balloon more freely over the spindle point.

Winding operatives should be prevented from reducing angle or amount of flannel board in use and thus giving reduced tension and cleaning, although perhaps preventing a few thread breakages.

When different counts and folds of yarn are in use it is probably best to have each thread board and flannel complete for each winder, so that tension for one yarn or one winder may differ from another.

A winding process of any kind and for any stage is usually a good place to ascertain the strength and quality of the yarn at any time. Snarls, bad piecings, bad ends, loose waste, bits of leaf, thin or cut places in the yarn, or other defects, usually manifest themselves clearly at this stage and should be eliminated.

In cases of sufficient importance it is easy to make personal observations and tests, tabulate these, and compare with other similar records. Trying debateable sorts with different winders may help to a correct understanding.

In some cases winders have fixed wages, but more often the method is a stated amount for a stated weight of yarn given to a winder, or taken away after winding; the latter being perhaps the soundest in principle but the former being often used because of its convenience.

Skewering of mule cops by winders, reelers, weavers or others, is always a point of primary importance to limit waste and facilitate production. Expert lectures and demonstrations of cop skewering have frequently proved beneficial.

Perspiring hands are bad for skewering as the skewers may become rusted thereby.

In drum winding there are usually three chief shafts, viz.:— the drum shaft, the stop-motion shaft, and the driving shaft, these may be oiled at least once and preferably twice per day.

The small top yarn extension bowls and the pivots of the cradle spindles may be touched with an oil pad, the spindle pivots rather frequently.

Traverse cams usually revolve in oil baths of cylinder or other thick oil. Spring buffers are sometimes used to minimise the blow force at each traverse end and to reduce danger of webbed ends on cheeses.

Productions of 150 to 200 yards per minute are obtainable in drum winding, the quick traverse being better than the slow traverse in production. For high class work, best quality, most

uniform results, and finer counts the slow traverse has still its advocates.

The speed of traverse in quick traverse frames has a strict relation to the winding-on speed in determining the pitch of the yarn spirals. To reduce the winding speed or increase the traverse speed alone, will in each case give a wider pitch or spiral of yarn, and softer bobbins.

Whether the slow traverse or the quick traverse is used in drum winding, the spirals will become more open as the bobbin diameter increases, because the winding speed is uniform; the traverse is also uniform, but the same length of yarn has to wrap round the cheese or bobbin for every traverse whatever the diameter. A cheese or bobbin of 6 inches diameter only uses the same length of yarn in one traverse as one of $1\frac{1}{2}$-inch diameter, and the $1\frac{1}{2}$-inch cheese has four times as many revolutions rate as the 6 inch. The more open the spirals the greater the tendency to wind softly, a feature which may become a serious defect if a cheese is slipping through unsatisfactory drum contact.

Bad cop noses, soft cops, nicked cops, bad cop bottoms, badly built cops, wrong sizes and shapes of apertures in the cops, weak yarn, are frequent causes of low production and increased waste in cop winding. Winding from ring bobbins reduces trouble from such evils as these and has increased of late years.

Occasionally bow-shaped spindles may be used as for shuttle tongues in weaving; and other special forms of spindle have been tried, and may be of value if different sorts of cops are to be wound on the same frame.

Snarls in single yarn are an even greater evil in doubling than in direct weaving because they tend in the direction of reducing doubled yarn to the strength of single yarn.

In making piecings of two-fold yarn which may need some unwinding from the cheese or bobbin there must be no crossing of one coil or spiral with another, and both ends must come off flush and even to the piecing.

Bad ends and loose waste are sometimes produced both in spinning and in winding by "wafting," with the machine working and not taking care to break the bad ends out.

Bunch knots are caused by all single ends of a doubled yarn being pieced together in one piecing, and single end piecing should be promoted as much as possible. In the "knotless" trade even these are sometimes avoided by using Balfe's piecing machine.

Nicking-in of yarn at the ends of flanged bobbins is the corresponding evil of webbed ends in quick traverse cheeses. In each case every care should be taken to reduce the evil to the minimum.

The Camless Winding Frame.

Slow traverse winders of either the spindle or drum type may obtain their traverse from either a mangle-wheel motion, or a plain heart cam.

Quick traverse winders frequently have the traverse supplied by a gearing end cam operating upon a long traverse bar.

The split drum winder has its traverse from each drum.

The camless or Foster frame gives the traverse or reciprocation to each thread by means of two projecting fingers or blades, revolving in opposite directions, and one finger carrying the thread across the face of the cheese one way, while the companion finger returns the thread across the bobbin face. Each finger is a double one. Neither cam, split drum, nor thread rail are required in this machine, and an "open" wind is obtained from it.

The double finger arrangement gives two "throws" or double traverses for one revolution of blades or fingers.

Wheel gearing is used to impact the revolution of the fingers, but there is no strain on the threads.

Speed of winding may be as high as ever required for stop-motion doubling winding reaching 6,000 or more inches per minute.

Hill & Brown Split Drum, Quick Traverse Winding Frame.

The split drum is essentially a quick traverse and is therefore designed to dispense with two-headed bobbins. Each drum is complete in itself, and imparts both the winding-on drive to the cheese and also gives its own thread traverse.

It is capable of giving the highest required speed of winding-on and traverse, and is therefore recommended on the modern vertical spindle gassing frame along with bottle-shaped bobbins to get maximum speeds. There is no shock, noise, or vibration at the reversing of thread traverse.

Wear and tear of cams, rods, and other parts of traverse motion are obviated. Each drum produces its own traverse and various widths of cheese or spool can be wound together on same frame, provided the correct widths of split drums are used.

The split drum method has found special favour for single end drum winding and in some lines of hosiery, etc.

For multiple end winding other types of doubling winder are often preferred. The use of long traverse rods is usually a stumbling block for high traverse speeds, but split drums on the one hand, or the Hetherington-Foster camless or double projecting finger method of traversing the threads on the other hand, represent quick traverse frames in which the long traverse rod is dispensed with.

The long traverse rod of small diameter and modern cams give speeds sufficiently high for most purposes.

Yarn wound in the split drum machine possesses the character-

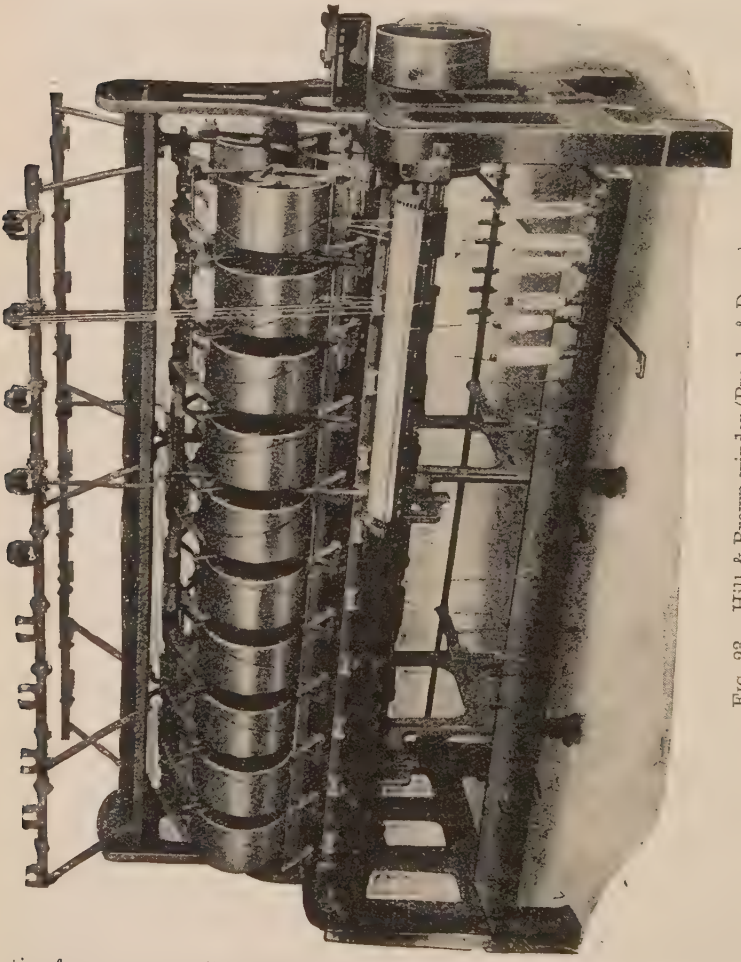

FIG. 23.—Hill & Brown winder (Brooks & Doxey).

istic of most "open" crossing cheeses in being suitable for bleaching or dyeing in the cheese or spool form.

"Each drum is driven separately from a central driving shaft by a band. The drum is made of two cams, mounted on a small shaft, which, when placed together, form a complete pulley or

drum. For the purpose of winding and traversing the yarn, the faces of these two cams are so set in relation to each other as to form one complete cam course with ample space for the yarn to pass freely into the drum. The yarn when passing from the creel

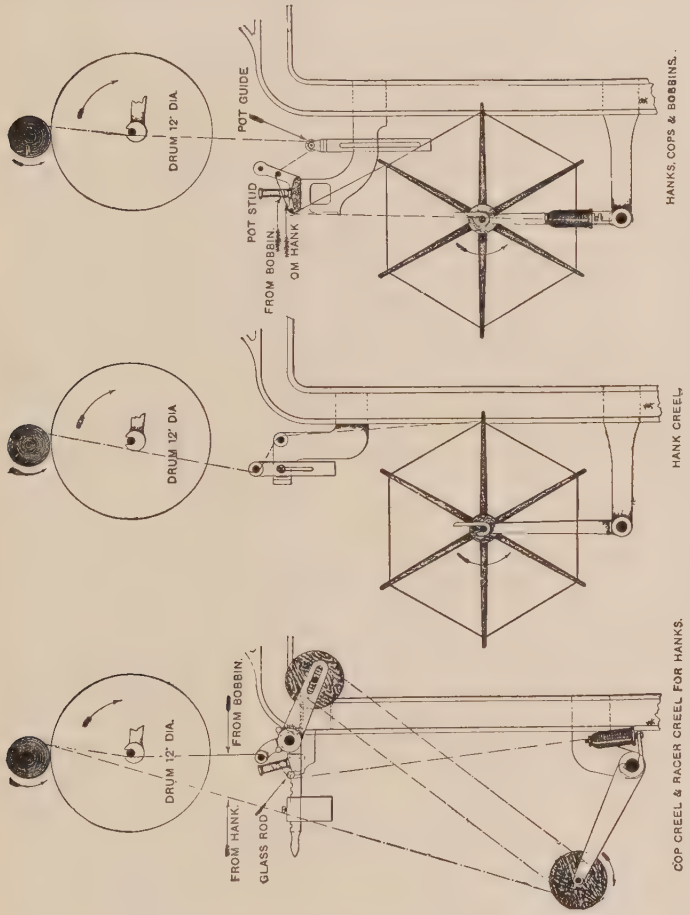

FIG. 24.—Hill & Brown winder of Messrs. Brooks & Doxey.

is laid into this space, and as the drum revolves it traverses it from side to side on the spool, the latter at the same time revolving by surface contact with the drum, and laying on the yarn as usual."

The plain machine is very suitable for single end winding. If this winder is required to operate on the doubling winding system

—from two to six ends together—a special machine with stop-motion to each end is made.

The winding is done upon the top of the drum and the yarn may pass directly from the detector wires through the drum to the spool, or the well-known light top thread bowls may be used, these being scarcely recommended for fine or tender yarns owing to increasing the drag or tension. Also pasted cop bottoms are opposed to these top runners as these latter cause breakages at the drum.

Various details of the split drum, Hill & Brown winder, of Messrs. Brooks & Doxey, are shown in Figs. 23, 24.

On this type of machine each drum is separately driven by means of an endless cotton band. When used for winding one end only, and without automatic stop-motion, the drums revolve in fixed bearings, each drum being stopped by hand when it is necessary to insert the yarn in the slit of the drum.

When used as a stop-motion or doubler winder each drum is carried in a separate cradle, the reason for this being that when an end breaks the drum affected is caused to fall on to a brake and is thus brought to rest. This action has a double effect, viz. :—

1. The spool or cheese falls on to a stationary guide which stops it, and,

2. The driving band of the drum is slackened, thus facilitating the action of the brake referred to in stopping the revolutions of the drum.

Messrs. Brooks & Doxey at one time patented a new device for driving the drums on this type of machine by friction.

The friction pulley consists of an indiarubber or felt washer bolted to a cast-iron disc, arranged on a driving shaft behind each row of drums—one disc per drum.

The independence of each drum is still maintained. One end or pivot of the drum is carried in a fixed bearing whilst the other end is carried in a movable bearing held in working position by means of a lever or handle. When this lever is raised the drum falls out of contact with the driving disc, and is at once brought to rest by means of a brake which falls against the drum.

A further improvement was coupled to the above device, viz. the guide behind each cheese which is used primarily for guiding the yarn on to the cheese, and which is " fixed " in the old case, is now caused to travel between the cheese and the drum (when this latter is thrown out of action consequent upon an end breaking), thus stopping the cheese in the shortest possible time and reducing the waste made.

Summary of the more important advantages of friction driving, which it was hoped to obtain.

1. Greater production because of more positive driving and increased facility in piecing-up.

2. Less waste because of quicker arrestation of winding when an end breaks.

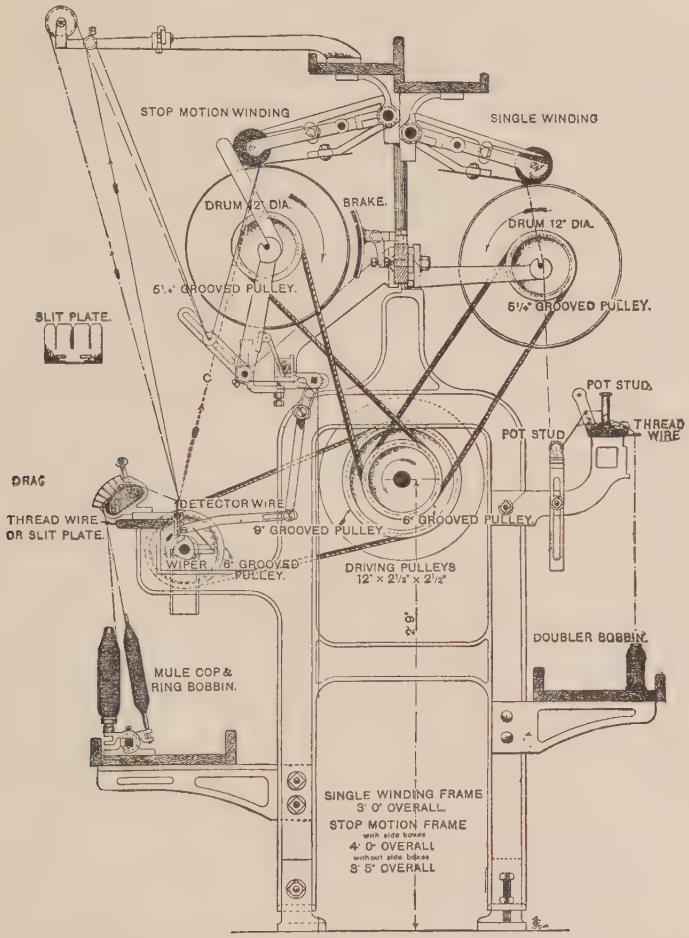

FIG. 25.—Details of Hill & Brown Winder (Brooks & Doxey).

A.—Method of threading the yarn with tin top runner for medium counts and good quality single yarns.

B.—Pot stud in lieu of wood top runner for coarse counts.

C.—Method of threading the yarn without wood top runner or pot stud, the arrangement for five counts and all weaker qualities of single yarns.

3. 20 to 30 per cent. less power required to drive the stop-motion machine, because with friction driving when the stop-motion

acts on the breaking of a thread the constant friction of the band on the stationary drum is entirely saved.

Winding frames are generally made with spring pieces and frame ends having loose feet for adjustment on uneven floors. It is advisable that each bearing shall rest firmly on the floor and each do its fair share of the work, and adjustable feet are probably better than using wood packings, especially if frames are moved.

The Hill & Brown winder is made either single or double cam, the former traversing the yarn once each way for each drum revolution and the double cam twice each way. Double cams are most used up to and including 3-inch traverse, but for wider traverses and winding most qualities of single yarns either singly or several ends together, the drums are made single cam.

For some yarns, however, particularly hard-twisted and doubled yarns, and when winding from revolving bobbins, it is often found best to use cams with double drums, because in winding such yarns, bulging is liable to take place at the ends and extra crossings given by double cam or other method help to overcome this. Increased diameter of empty spool or bobbin always tends to diminish the amount of webbing or bulging, whether obtained by using spools with swelled ends only or spools of large diameter all over.

Diameters of split drums vary from 8 inches to 18 inches as per requirements.

Maximum speeds of winding are obtained when winding the yarn over the end of cop or bobbin.

If conical winding on taper tubes is required a special set of screwed arbor and spindle may be got to suit the taper required. These paper cones are for transit and export purposes.

The plain conical spool is sufficient when winding directly upon the wood cone for home use instead of using a paper tube.

Ball Drag (see Fig. 26).

This ball drag consists in the main of a porcelain cup having two V-shaped slots in it and at the bottom an aperture. In this porcelain cup a steel or glass ball is placed and the weight or size of the ball, which imparts the required tension, chosen to suit the counts of yarn to be wound. These porcelain cups with inserted balls are suitably mounted into wooden rails and then placed into position on the winding machine and the flannel drag rail is "scrapped." The skewer holders or cop rail are then brought forward and set in such a position that the cops or bobbins stand vertically and the yarn is unwound over the nose. The machine is then ready for the winding operation, and the operative takes the yarn from the cop and passes it through the thread-wire on the

wooden pot rail and in so doing the yarn passes automatically under the ball and is pieced-up to the warper's bobbin. The ball,

FIG. 26.

bearing as it does on the bottom of the porcelain cup, has two brake points, and in its passage under the ball the yarn is subjected to the necessary drag or tension and the two brake points

prevent any undue "soft" or "roving" passing through, as the weight of the ball, selected to suit the counts wound, ruptures the "soft." In addition to acting as a drag element, the ball clears the yarn of foreign matter, such as leaf, etc., and this refuse is deposited through the aperture in the bottom of the porcelain cup on to the floor. The nap on the yarn is not destroyed but goes through on the yarn and is practically in the same condition (excepting that all undue "soft," etc., has been taken out), as when it comes from the spinning machine, and the ultimate benefits are great.

The ball revolves with the yarn, but bears on the bottom of the cup, and has therefore two brake points. The rolling action of the ball retains the major part of the loose fibres and frictional contact on porcelain cup removes leaf, etc. The "soft" having been taken out at the winding frame, the yarn will warp better. The ball drag permits possibly 50 per cent. of the "nap" or "cover" to remain on the yarn, and this is better for sizing and therefore for weaving.

Drag or tension may be changed by changing the ball in the porcelain cup, or by raising or lowering the pot rail. The ball drag permits the cops to be placed vertically in the winding frame, and this tends to reduce waste and enables the winder to remain more in an upright position. There is reduced tendency towards accumulations of fluff and fly.

The makers recommend the following weights of balls :—

$1\frac{3}{8}$"	steel	ball,	about	500	grains,	suitable	for	ring	twist	up	to 38's.
$\frac{3}{4}$"	,,	,,	,,	433	,,	,,	,,	mule	,,	,,	38's.
$1\frac{1}{16}$"	,,	,,	,,	338	,,	,,	,,	,,	,,	,,	40's./70's.
$\frac{3}{2}\frac{1}{2}$"	,,	,,	,,	291	,,	,,	,,	,,	,,	,,	70's./100's.
$\frac{5}{8}$"	,,	,,	,,	246	,,	,,	,,	,,	,,	,,	100's./120's.
$\frac{3}{4}$"	glass	,,	,,	100	,,	,,	,,	,,	,,	,,	upwards.

In winding voile or crepe yarns, with their extra twist, the ball drag does very well in preventing snarls.

Ball drag can be applied to any make of existing frames, warp winding, doubler winding, twiner creels, hosiery machines, and pirn winders. Some users prefer revolving washer weights.

Weft Winding.

For most kinds of cotton cloth, the comparatively frequent reshuttling of the weft has always been a great trouble, causing much work, and not being healthy for the operatives by the more usual "sucking-in" of the weft. Shuttle changing and cop changing devices are in use in automatic looms, and there are various hand-threading and self-threading devices obtainable for easing the work connected with the supply of weft to the looms.

One of the particular methods of helping in this direction,

which has received attention of recent years, has been the re-winding of weft into much more solid packages than can be produced on the spinning machines, thus allowing a weft cop to remain much longer in the loom before becoming finished.

The Universal Winding Frame Co. of Saville Street, off Oxford Road, Manchester, and of the U.S.A., have devoted much time and effort in this direction. Warp yarns receive considerable preparation before reaching the loom, and it is possible that weft yarn can be put into better form than left by the final spinning machine. In regard to mule cops, a greater length of yarn can be got on a re-wound cop, while ring yarn may also be transferred from pirns to cops.

The descriptions given below refer to an American weaving shed.

The Universal Winding Co. are operating a small weave shed near their factory in the United States where they have installed a number of plain 40-inch looms to weave 40-inch sheetings 80 inches by 80 inches square, 4 yards to the pound, 30's warp and 40's weft. Their looms are running at 165 picks per minute, and are fitted with mechanical stop-motions. These looms are standard in every respect, carrying a special designed shuttle 15 inches long, the front wall being $1\frac{1}{4}$ inch high and back wall $1\frac{1}{2}$ inch high. A shuttle of this shape enables the use of a cone base weft bobbin 8 inches long, $1\frac{1}{4}$ inch in diameter, which contains approximately 1,000 grains of 40's single weft, thereby establishing a continuous loom run of 25 to 30 minutes.

With this length of weft only two shuttle changes per hour per loom are called for; therefore, an operative running 12 looms only changes 24 shuttles per hour, less than 5 minutes out of the hour being taken out for the 24 changes. It is plain to see that this practically makes weaving a warp job, and establishes a continuity of loom motion which in itself affects co-ordination between the two essential elements heretofore referred to—i.e. machine and materials, while it naturally follows that the effect on the third element is progressive.

Weft waste is the source of considerable loss in the weaving process, and this loss, if rightfully figured, is oft-times greater than manufacturers appreciate. Weft waste made in weaving should be estimated as the difference between pounds spun and pounds represented in finished goods, while the loss is the difference between the price received for waste and the value of the material in fabric woven. When weft yarns are wound in long lengths for weaving, about $\frac{1}{2}$ to 1 per cent. of waste is made in the winding process, while practically no waste is made in the weaving process.

Loom weft in the grey condition is mostly used in the loom in the cop or bobbin form, as it leaves the mule or ring-frame. Of late

years there has been a tendency in some cases to re-wind simply to put the yarn in better form for the shuttle, and to obtain better built and firmer cops, containing, perhaps, twice as much yarn. In the "bump" trade jumbo winding has long been generally adopted in order to produce long, hard, compact cops, suitable for the shuttle of sponge cloth looms. Messrs. Robert Hall & Sons, of Bury, have made many such winding frames, each spindle driven by bevel wheels, each one knocking off when the cop becomes sufficiently long, and the cops built up on the cup or pirn-winding system, the yarn to unwind from the base of the cop, at the loom. The Universal Winding Co. have made many re-winding frames for fine and medium counts weft.

The drag, speed, and detailed adjustments connected with the traverse motions need to be well regulated to the counts, twist, and general character of the yarn that is under treatment. Pirns need to be correctly shaped, firm, full workable size, and likely to weave off without breakage.

Pirn winding frames of the cup style, and other long-established methods, have not been noted for best results. A cup winder subjects the yarn to much abrasion. Yarn is given off at variable speeds and tensions for different diameters of cops or bobbins. Bleached, dyed, or mercerised weft yarn has often to be re-wound from hank form from reels or ryces working in twisted stands, or there may be dirt and wear in the spindles and bearings for the ryces, so as to affect the re-wound weft cops.

Bad setting of skewers and guide eyes, or worn skewers, overrunning of skewers or ryces, too free ballooning of the yarn—such features affect the question of re-winding considerably.

Referring again to cup or pirn winders, these often give plucking of the yarn when winding from ryces, and there is sometimes a glazing of the yarn by the cup, and an amount of rubbing which is bad for the strength of the fibre. Under such circumstances winding speed rates should be kept pretty low.

Pirn cups, spindle wharves, and spindles should be accurately adjusted, the spindle heads should be of correct weight, the slots in the wharves should be kept free from dirt and fibre, and strained spindles should be avoided. Want of attention to these points may prevent the free rising of the spindles as the cops lengthen, thus increasing the rubbing effect of the cups on the yarn, and deteriorate the yarn in regard to its "cover" value, strength, or elasticity. Spindle bands in this position, as in others, need to be of correct tension and not over greasy. The peculiar slotted wharves should revolve freely. Loss of spindle speed may give too open coiling of the yarn since the traverse is positively operated. Soft and ridgy pirns are to be avoided in every way, or there will be short lengths of yarn, and the yarn will easily break at the loom. The pirn cup

winder works best when the yarn goes to the bottom of the slot each time in order to prevent short, thick cop noses. Speeds of spindle and of traverse, and size of cups require adapting to the counts of yarn and size of shuttle to get best results.

Neither in this or any other tin roller winding frame should the spindle bands pull up or down at the wharves.

It may be that different frames are purposely set out to make pirns of different lengths or diameters, and care should be taken not to mix these, or some shuttles will get cops too large and others too small, meaning waste and time lost in both cases. In pirn winding there may be trouble with the rectangular spindle blades wearing round at the edges, or there may be wear in the slots for the spindles in the wharves. Winders should be taught to tie true figure-of-eight knots.

Drum Winding.

In grey yarns the vertical spindle winder has always been strongly in favour for warp yarns, although the drum winder has found some acceptance.

For re-winding coloured yarns the slow traverse drum winder —often of the latch and catch description—for winding warp yarns upon flanged bobbins, has always been more or less in use as a rival to the vertical spindle frame. Drum winding has the fine advantage of uniform winding speed, but has a tendency to rub or glaze the yarn more than the rods and slots of the vertical spindle machine.

Slippage of the bobbin due to large knots in the yarn, or imperfect contact of drum and bobbin, increases the rubbing effect on the yarn, and to check this care should be taken to have the bobbin spindles running freely in their bearings, and set quite parallel to the drums. Bobbin cradles should be properly weighted at both ends to keep a firm contact of bobbin and drum. These difficulties are increased at the quick traverse winder by the tendency towards webbing the cheese ends.

Vertical Spindle Machine.—More than fifty years ago, as a little half-timer, the present writer helped winders on vertical spindle winding-frames, which were then many years old, and differed very little from present-day frames. There were then the same problems of drag flannels wearing out, and either to be renewed or else altered in position; single vertical yarn clearing slits—termed by the winders "devil-catchers"—which required to be adjusted for height, and to be of correct opening for the counts of yarn used, spindles requiring to be suitable in size and shape to the mule cops; trouble with perspiring hands affecting the spindles; foremen whose only idea of increased production was to speed up tin rollers,

which were already too high in speed; guides so badly set that lumps of yarn were wound thickly at one flange of the bobbin; cops with badly pasted and soft cop bottoms, soft, bad noses, doffed too soon, not thick enough, slack strings, or yarn too weak.

One trouble with high spindle speeds is the continued use of the back and front rows of spindles in which the front row has a much higher speed than the back to take the bobbins first, and then transference of bobbins to back row.

The desire to get an extra amount of yarn on each bobbin intensifies the rubbing effect of the yarn on the guides. Guide bars, clearer slits, drag boards and all contacts with the yarn should be kept free from fly and dirt, since winding frames are expected to clean yarn and not to cause bad ends.

Nicking-in of the yarn due to bobbins winding soft may easily be a serious evil. Bobbins may be either barrel-shaped or wound straight, but in either case we should avoid ridgy bobbins, bad ends, large and slovenly knots, soft bobbins, nicked-in bobbins, bulged ends, too many knots due to thread weakage.

Knot-tying Devices.

Mechanical aids in the tying of knots in the yarn by winders and weavers are now very much appreciated, and there are various devices on the market.

While some operatives are careful and competent in tying small, neat knots in the yarn, others make large and clumsy knots. Mechanical knots vary from the completely automatic kind to others which simply help the winder in doing the work.

Weaving and Winding.

Increased attention to the question of automatic looms such as the Northrop has usually been attended by increased attention to winding, warping, and sizing, let alone the subsidiary operations of twisting-in or drawing-in. Another foremost consideration has also been the quality of the warp and weft yarn, and the form in which the mule cop or ring bobbins of weft have reached the loom. Tape drive and jockey pulley for driving winding frame spindles appears to be more popular in America than England. A good quality of twist yarn, and a low speed of winding frame spindles, may reduce the winder's work and improve it greatly. In some cases, instead of minding a straight side on the winding frame, it has been deemed best for a winder to have a half-back and half-front side on the principle of a pair of roving frames to mind. Vertical spindle winding frames in this country have almost always had two rows of spindles, in some cases—more in America than in

England—winding frames only contain one row of spindles. Custom influences this detail, and it may or may not be better for a firm to convert from one to the other. It has been stated that a winder in America, with single rows of spindles, two half sides, on twenty's yarn could attend as many as 100-140 spindles, and one weaver to as many as 40 looms. Most English mills have a good way to go in yarns, machines, methods, and workers to reach these figures.

Winding frames would certainly work better if more attention were bestowed on keeping the spindles in exact line, drag maintained as exact as possible, bobbins and bobbin flanges, yarn brought to and taken away from the winder by other persons.

Warpers beams, bobbins, creels, and skewers should be up to the mark. Bad beam ends certainly give slack and tight selvedges.

Principles and Efficiency in Doubling Winding.

Probably no machines in connection with cotton spinning and doubling have been more subject to detailed improvement during the last twenty years than have doubling winding frames of one make or another. Larger productions, better bobbins or cheeses, fewer breakages of threads, and more special effects are now obtained from these machines than were deemed possible a very few years ago. To be considered really efficient, it is necessary for a modern doubling winding machine that it shall have good traverse bar or thread guide arrangements, well contrived and well-arranged cams, or equivalent apparatus; that it shall make sufficiently hard cheeses or bobbins without webbing or running off; that it shall be capable of a high speed of winding, shall not make much noise, and shall be fitted with an efficient detector stop-motion, which shall be capable of very promptly stopping any individual cheese or bobbin when any single thread shall break. These effects are obtained in most frames chiefly by improved cams working in baths of oil; the use of extremely light traverse bars; and well balanced and connected parts of the stop-motion. There is difference of opinion in regard to methods of adjusting the tension on the threads. In many cases flannel-covered drag boards are used, and by keeping the yarn longer in contact with these the tension on all the threads is increased. A heavier detector wire will tend to put more tension upon any particular thread. In one case each thread is drawn beneath very light washers or weights, whose number or weight can be varied at will and immediately.

In another case the yarn is drawn beneath a ball-bearing in a manner which both tensions and cleans the threads. The ability to adjust tension of threads to suit individual cases is a great convenience when comparatively small lengths or weights of yarn are

required to be wound upon short lengths of a frame, or upon a few cheeses only. If a common traverse is used it is important to adjust each thread guide to its exact position for the bobbin or cheese.

Yarn Conditioning.

Special yarn conditioners for winding frames are obtainable if required. In one case a galvanised iron roller, 2 inches diameter, with brass ends and bearers, revolves in a zinc trough of water. The yarn passes over the moistened surface of this roller, and the amount of moisture put into this yarn is regulated by the speed of the roller, the latter being regulated by a 3-speed cone pulley. This is more for single winding containing no stop-motion. If applied to a stop-motion doubling winder the water would tend to rust the detector wires and other parts of the stop-motion.

Variable Driving.—Cone drum driving is occasionally applied to small winding frames when single thread winding is wanted for cops at one time, and hanks at another time, and when a great variety of yarns may be required to be wound. The cone driving permits ready alteration in speed of frame, but is not wanted for stop-motion winding frames.

Speeds.

Single winding with Hill & Brown machine, and unwinding over the end of mule cop or ring bobbin, may attain a winding speed of 200 yards per minute. From revolving bobbins about 140 yards per minute; from hanks about 90 yards per minute, although from double cotton hanks 150 yards per minute may be reached. Winding speeds vary greatly.

An ordinary cheese of 6 inches diameter × 5 to 6 inches traverse, may be made to contain over 25,000 yards of 40's/2 yarn.

For stop-motion winding with two or three ends together the speeds need not be much different from foregoing.

Flanged bobbins in winding, and flanged beams in warping are alike in possibility of bad edges. Small "side end" or selvedge motions have been successfully applied to many beams of recent years, and special cam arrangements have been devised for obtaining the best of edges on warper's flanged bobbins. The best thing, however, is to take pains to adjust the traverse as accurately as possible.

In drum winding the traverse is constant and the winding speed is constant, so that number of coils per traverse diminish in proportion to increased diameter whether quick or slow traverse.

Round wire traverse bars of about 5's wire, or the equivalent in square or oblong section, have aided materially in obtaining quicker speeds in quick traverse winding frames.

In some quick traverse winding frames it is possible to alter the speed of drum, without altering the speed or rate of traverse.

It might be suggested that better cheeses would sometimes result if either the winding speed or else the traverse, were automatically varied as the diameter of cheese increases; but this would compel doffing all cheeses at one time.

The split drum system sometimes gives one complete there and back "throw" for one revolution of the drum, and sometimes two complete "throws" by using a double cam drum. Some such relation of "throw" to "revolution" is often aimed at in designing gearing end cams, but there is always the difficulty that increase of "cheese" diameter gives fewer spirals and of a wider pitch per "throw." With fixed "ratios" of traverse and winding speeds it has often been found that cheeses were softer in the middle and hence attempted to diminish thread tension at the ends. For fine and high-class yarns some prefer the many coils of the slow traverse winder.

Drum winding may be done either on a cone bobbin, a parallel bobbin, or a paper tube; $1\frac{1}{8}$ inch is a common diameter for the parallel bobbin, $\frac{1}{2}$ or $\frac{5}{8}$ inch for paper tube, $1\frac{5}{8}$ inch at thick end, $\frac{5}{8}$ inch at thin end for cone tube. Other sizes as required, one market taking a cone of 1 inch at one end, $\frac{5}{8}$ inch at other end. Take the extreme case of an empty gassing tube, $\frac{1}{2}$-inch diameter, compared with a 7-inch full diameter, the coils per traverse would be fourteen times as many for the $\frac{1}{2}$-inch diameter, as for the 7-inch diameter, with corresponding variation in pitch or in number of coils per traverse.

Winding masters will be well advised to study this question of relation subsisting between coils per throw, pitch of spiral or coil, variation in these for increase in cheese diameter, effect on webbing, effect on hardness of bobbin or cheese.

The effect on the opposite ends of a cone cheese also requires consideration.

Universal Winding Frames.

A good many frames have been built for cheese winding on the International or Leeson system.

Such a frame is high speed, mostly quick traverse, horizontal spindle, giving hard wound symmetrical packages, built up on the spindle winding principle, with a uniform rate of traverse but a variable rate of winding.

Let the fundamental difference between drum and spindle winding be very clearly understood.

Drum winding gives uniform winding speed but variable pitch of coils.

Spindle winding gives uniform pitch of coils but variable rate of winding.

A variable rate of winding speed is undesirable of itself, but appears necessary in order to get uniform pitch of spiral or coil, and this latter is important for close winding, and maximum hardness of cheese or package. The "close" winding of the spindle method will give harder packages than the "open" winding in the drum method.

In spindle winding the winding speed increases at the same rate as the cheese diameter increases, and in this way uniformity in number and pitch of coils is maintained for all diameters of cheese.

The Leeson winding frames are adapted for winding fibrous materials of all kinds, twines, cords, linen, worsted, woollen, silk, or cotton threads or yarns, into cops or packages, either cylindrical or conical, varying in size from the smallest shuttle cops for sewing machines to those weighing 50 lb. or heavier.

Universal Winding Machine.

Floor space. 5 feet 7 inches × 2 feet 6 inches overall.
Spindle speed, 900 r.p.m. Pulley, 3½-inch diameter.
Horse power required. ½ H.P. per gang of 6 spindles.
Length of package. 2 to 6 inches.
Gross weight packed. 700 lb.
Cubical contents packed. 27 cubic feet.

In Fig. 27 is shown one of many varieties made by this well-known company.

In preparing yarn for insulating wire, it is essential that it should be wound with uniform tension, and that the alignment of the strands be perfect, otherwise the wire would not be properly covered and the insulation would be defective.

This machine is fitted with adjustable metal plates on which is stretched flannel, which not only thoroughly cleans the yarn, but also applies uniform tension to all of the ends.

For the grouping of fine yarn up to eight ends sensitive stop-motions are used, so that when any end breaks or one of the supplies runs out the spindle stops before the end can reach the package. This enables the operative to tie-in a single strand and avoid bunch knots. The product of this machine is not only used for insulating wire, but, when more than eight ends are required, it forms a supply package for the No. 14 Multi-Multiple machine.

In winding by the International or Leeson machines the thread may run over a guide in a straight line direct to the tube, and the

coils may be laid side by side, touching each other, but without over-riding or crushing each other. Each layer may be laid

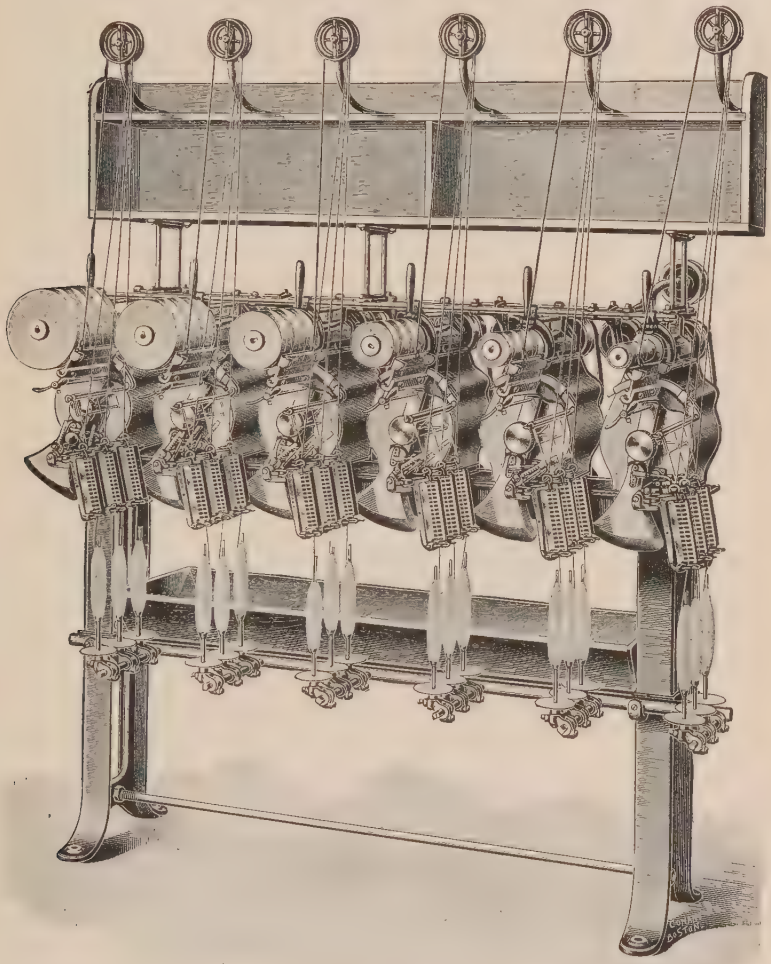

Fig. 27.

exactly similar to the preceding one, consequently each is laid upon a firm supporting surface, without spaces, and the material is maintained in perfect condition without crushing or impairing the

twist. As the coils do not often pass across the end of the cop, the thread can be drawn off the periphery of the cop over the end without catching or increasing the tension, thereby giving good results in delivery to high-speed machines.

An inexpensive paper tube is substituted for the ordinary spools or bobbins, and as the thread is laid upon the tube in such a manner as to be self-supporting, it does not require end flanges such as are sometimes used in ordinary thread winding. The expense of spools is thus dispensed with, and at the same time a saving in bulk of packages is thus secured.

A spindle winding frame has the feature of uniform spirals of yarn but uneven speeds of winding.

A drum winder has the opposite effects of uneven spirals or coils of yarn and uniform winding-on speed.

Variety of Use.

By the Universal or Leeson system of winding the material is wound upon a supporting centre in regular helical coils which reverse with a sharp bend, each coil crossing over the next preceding coil, binding it in place at each crossing. The coils being in excellent alignment, a very compact, self-supporting spool or cheese is produced.

By a simple adjustment, the coils can be laid to form a "close" wind, with the adjacent coils in contact, or can be "spaced" as the character of the yarn may require, but with either adjustment maintaining absolute uniformity throughout the package.

High speed of spindle, economy of floor space and power, and comparatively few spindles per frame, and horizontal spindle winding, are associated with these particular machines.

This system of winding is adapted to the complete range of textile materials for which winding is required, from the finest counts of single or doubled yarns, or fine insulated wire in disc form the size of a wafer, to cylindrical packages of rope each 75 lb. weight.

Many types of these machines have been made to suit specialities, such as winding cops for use in sewing machine shuttles, tape on tubes for shipment, bobbins for use in braiding machines, paper twine, tinsel cord, asbestos, copper wire, and solder.

Of late years winding frames have developed along the lines of spinning and building mule or ring weft cops or bobbins much too large for the loom shuttles, and then re-winding on spindle machines of the Leeson or other special type into cops or pirns for the loom shuttle, such cops being very hard wound and containing double amount of yarn.

Increased length on shuttle cops means better and more cloth from the loom, along with reduced work for the weaver, although the costs of the winding must be accounted for against the loom benefits.

A special adaptation of this machine provides for winding large diameter bobbins as a supply for reinforcing yarn on knitting machines.

Hank Winding.—Winding of yarn from hanks or skeins by rotation of swifts requires careful treatment to avoid waste through tangling and breakage of yarn, especially if maximum speed of swift is required without over-running, and also it is desired to start the swift or reel without too much pull on the yarn.

Fig. 28.—Filling winder.

In a special device obtainable for these hank winders the yarn is drawn through the end of a sensitive lever, which acts on the hub of the swift and starts the same into rotation before any yarn is drawn from the swift.

It would be possible with this device to use a winding spindle making up to 2,000 r.p.m., winding fine silk or cotton yarns from hanks or skeins.

Notes on Leeson or Spindle Winding.—For coning hard twist and fly yarns the "regular" taper may be used, while for soft spun yarns for very free delivery to knitting machines, the "nutaper" cone may be used.

In most cases it is best to have one cheese on one spindle, and this is better for doffing. In some cases, however, as for mercerised

yarn and bleached thread, marketed in small packages, with short traverse and small diameter of cheese, two spools may be made together on the same spindle.

In a Leeson spindle doubling winder, cops, ring bobbins or winders bobbins may be placed in the creel, and two to six ends wound together in a firm package for the twisting frame creel, a single end stop-motion being provided to stop the spindle before the loose end runs in. This facilitates the tying of single knots instead of bunch knots. Various special yarn tension devices are applicable to these International or Leeson winding frames.

Moisture.—For the purpose of applying moisture to silk or yarn for use in knitting, one of these winders may be provided with a trough extending across the front, in which is a non-corroding metal roller partially submerged in the moistening solution. The conditioning roller may have any suitable speed. The spindles are fitted for holding wooden cones which are best enamelled to resist the cracking and warping effects of the water.

Warping.

It is possible to place cones built on the Leeson system into the creel of a warping machine. In this case it is perhaps best to use a special creel to hold the cones and guide the yarn for end unwinding, means being provided to give a uniform yarn tension.

A high warping speed is obtainable in such cases, especially if the yarn is often fair quality; 200 yards per minute has been mentioned for such a case.

Two or three warps can be supplied on one set of cones, reducing creeling trouble and waste.

Yarn surplus on the cones can be back wound. Many prefer slow traverse flanged bobbins.

Quick Traverse Drum Winder.

The simplest form of machine may only wind one end from cop or bobbin to each cheese or drum. Six ends up per drum is a frequent size, while arrangements may be made for winding as many as twenty-four ends up together on the same drum.

Cheeses may be for the standard conditions of 6 inches width × ·322 inch bore, 5 inches traverse, to 6 inches diameter of full cheese.

Other dimensions as required, such as 8 inches gauge for 6 inches width of cheese, or 10 inches gauge for 8 inches width of cheese.

Doubling winders are now very generally capable of winding either parallel cheeses or conical ones of any desired taper.

Each cradle may readily be adjusted to give the desired effect in this direction.

Winding for Hosiery Purposes.

There is a very great amount of trade done on this basis, and quite a number of spinners who spin only, i.e. who do not go in for doubling, have put down winding frames in order to meet it. The requirements of the winding process for this trade are very exacting, as the majority of them find from experience, and a cone which for many other purposes would be quite satisfactory, is impossible for knitting machines.

The principal requisites are that the cone should be well and firmly built, and that the coils at the small end shall not be loosely wound so as to accelerate the rate of delivery when winding from that point.

Uniform rate of delivery at all points from the commencement to the finish of the cone is essential to the successful operation of the knitting machines, as if otherwise, the tension of the yarn is interfered with, and this touches a very delicate adjustment of the machine and interferes with the proper "locking up" of the stitches. Twist per inch is usually low.

This primary factor governing the build of the cone ought to be known.

Secondly, all slubs, thick places, bits of seed, leaf, or other general impurities must be cleared out, and this is usually a difficult matter. The yarn must not be "raised" during this process. This requires that the yarn should be cleared with as close a setting as possible without scraping, and in this respect the cast-iron clearer plates, well polished on the edges which come together, give more satisfaction than any other type. The tensioning of the yarn to make a firm solid cone is best done by the use of some type of non-abrasive tension device, such as the use of porcelain studs, or well-polished metal plates, between which the yarn passes.

The type of winder with a constant speed of spindle is preferred by the majority of the hosiery manufacturers, as they claim (now speaking of those who wind their own cones, and quite a number of them who buy yarn on cones re-wind again themselves) that the constant angle of the thread gives a more uniform delivery when unwinding than the decreasing angle of the drum wound cone. This effect is to them very marked as they regularly ask for nine to ten cops to be wound on one cone. Thus a drum wound cone tends to come off more freely when full than a cone made on the constant spindle speed winder. They have often had sent them drum cones which they have used without trouble, but they are backed up in their statements by practical experience.

Yarns spun on the ring-frame are now often wound upon cheeses on the quick traverse machine, to present the yarn in a convenient form for transit purposes, instead of being at the trouble

and expense involved in the carriage of ring-frame bobbins. Although bobbins may be used at the drum winding frame, yet they need not contain flanges, and such a large amount of yarn can be quickly put upon one single bobbin that the expense is low. The system of rapid cross-winding allows of the building up of a firm

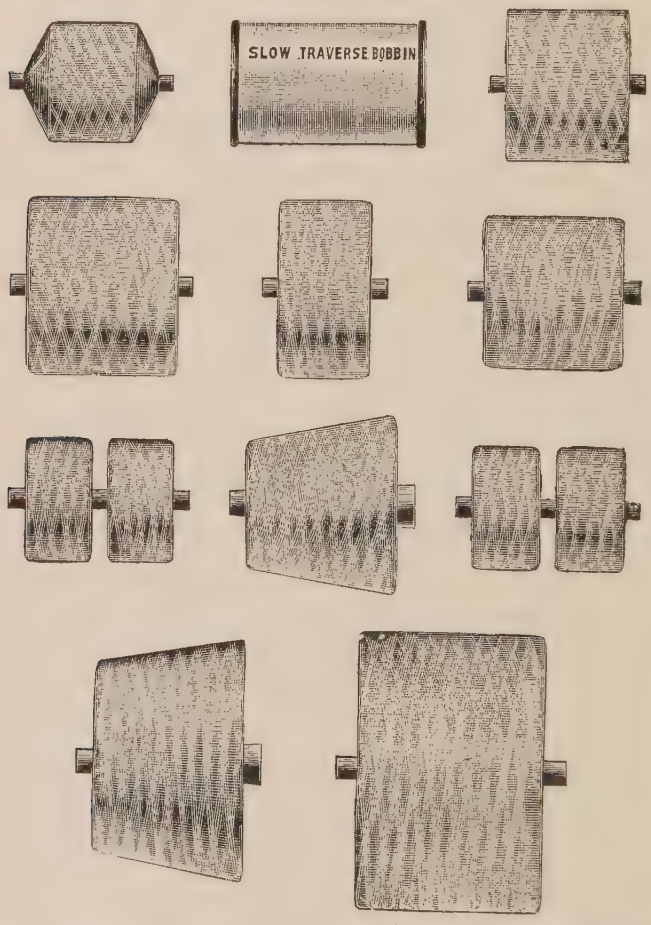

FIG. 29.—Various types of cone and cheese.

cheese, without running off at the edges. Very often paper tubes are used.

Although the same machine may be used when the yarn has to be doubled, yet two or more ends in this latter case are invariably put together, and a single preventer stop-motion must be used.

The ordinary vertical spindle winding frame, or the drum winding frame, with slow traverse may be sometimes used to prepare yarns for the warping machine when it is intended to sell yarn in the form of warps. The twiner, of course, converts the spun cops of single yarn into larger cops of double yarn, at the same time twisting the single threads together, so as to form a doubled thread.

Doubled yarns are sometimes passed through the winding clearer frame to clean and rid them of knots and irregularities.

Various kinds of bobbins as made on doubling winding frames are shown in Fig. 29.

Tension and Strength in Winding.

Take, for example, the case of winding ring yarn at the vertical spindle winder, over the end of the bobbin, or from the side of a revolving ring bobbin.

There is usually a more regular tension applied in the case of side unwinding and firmer warper's bobbins are obtained, so long as the yarn is strong enough to withstand the tension.

Tension has much to do with the strength of twisted threads, and it must be remembered that twist tends to run into the thinner portions of either a spun or doubled thread.

On one occasion with certain drum winding frames having quick traverse, the present writer noticed bobbins at intervals which were winding very soft and with a very open spiral. On examination it was found such bobbins were slipping on the drums, and each contained a less amount of yarn, while the necessarily wider spirals due to the traverse maintaining full speed, helped to give a softer feel to the cheeses.

For soft and × × soft 2- and 3-folds variations in strength and tension are perhaps not as important as for sewing threads in which the maximum amount of strength and regularity are required. Tension greatly affects the "set" of doubled threads.

In making two and three cords it has become a common practice to wind the two and three ends together at the drum winder and then do only the twisting at the doubler.

Some practical men contend for the alternative custom of winding single ends on flanged bobbins to get maximum creel lengths, and then place these in the creel of the doubling or twisting frame and do both operations at this latter machine instead of using the doubler winder.

It is contended for this method that the slower yarn speed of the twister is more conducive to uniform work and strength of doubled yarn than is the quick rate of winding at the doubling winder. The loss in strength is given at 6 or 7 per cent. average.

It is well known that ring-frame yarn spun upon ordinary twist ring bobbins, is usually assembled in some more progressive form at the spinning mill to save the expense and trouble incidental to the carriage of ring bobbins.

Reeling into hanks, beam warping, and cheese winding, are amongst the most common forms of assembly.

When the yarns are intended for subsequent doubling the assembly may take the form of cheeses or cones which are produced either on the single end winding or the doubling winder principle. It is contended that the single end winding is better for strength for reasons above given, but doubling winding is better in reducing the amount of labour at the twisting frame and in preventing "single" and "corkscrewed yarns."

Some doubling firms have purchased a great deal of ring yarn from spinners in the form of cheeses wound on paper tubes, but mule yarn for the most part is delivered in cop form to the doubler, so the latter may treat it as he desires.

Conical Bobbins.—It is quite convenient to arrange the average drum winder so that it shall be shaping either parallel or conical cheeses as required either on the whole or only a part of the machine.

Empty conical bobbins of the required diameter and degree of incline are used as required, and each bobbin holder or cradle may be readily adjusted so that each empty cone bobbin presents a parallel face to the drum.

Paper tubes over the conical centre may be used if desired for transit or export. The chief object of using conical bobbins or tubes is to permit unwinding over the thin end of each cone at the next process.

There is a winding effect or principle applied when making these conical cheeses of yarn that should be understood.

During winding the small end of each cone takes up the yarn at a slower speed rate than the larger diameters. Even the large end may take up slower than the surface speed of drum. With equal drum speeds a parallel cheese may wind on from 15 to 20 per cent. faster than a conical one in the same position.

Reelers and twiners have begun to use a good many of these cones of yarn.

High speed reels will balloon the threads nicely over the top edges of the tubes, and on twiners, a little rubbing may not matter at the much slower speeds. It is quite possible to reel over the ends of parallel cheeses, especially with gassing frame tubes of 3 inches width × 6 inches diameter. There is a limited amount of winding or making two cheeses simultaneously on the same spool or tube.

Single Drums. Slow Traverse.

A double drum winding frame has a line of drums running down each side of the machine.

A single drum winder has only one line of drums of larger diameter running down the middle of the machine, one drum driving two bobbins, one on either side, whereas in the smaller diameter drums of the double drum machine there is only one cheese driven by one drum.

It must be noted that with the single drum the cheese on one side of drum winds on the *inside*, while the cheese on the other side winds the yarn from the *outside* surface.

Apart from the slit drum series the single drum method more often takes 7 inches diameter, and perhaps its chief vogue more in slow traverse machines.

One objection alleged against the single drum method is the possibility of the cheese or yarn on one side affecting that on the other side.

It is possible to use a slow traverse drum winder for winding single ends from the hank, not having any yarn stop-motion, but using flanged bobbins. This kind of winding may suit when yarn has been bleached, dyed or mercerised in the hank.

The "latch and catch" winding frame used in some weaving mills is one example of this method.

Flangeless tubes—whether parallel or conical — find their particular use in quick traverse frames.

Also they are well suited for exporting yarn in cheese form, especially so if paper tubes are used.

Hard wound cheeses reduce the number of empty spools required, facilitate storage and export, reduce labour by taking much longer to wind and unwind, but are often strongly objected to when yarn is bleached or dyed in cheese form, a method which is perhaps on the increase.

Wear of Traverse Guides. Flanges.

The tendency for yarn to wear the sides or other parts of the traverse guides, is naturally more manifest in operating doubled yarns than in single end winding.

If required, it is possible to raise or lower the winding point in relation to the guides, or even to apply a special rod to the lifter, so as to put the yarn differently against the guides.

Accuracy of winding level at the ends of the bobbins or cheeses is exceedingly important, and needs careful attention, whether we use flanged or unflanged bobbins or spools. Every empty spool should be placed accurately in its position—a point which needs more attention when using flangeless spools.

"Webbing," or running off at the ends of the cheeses, has often been a source of great trouble in the case of quick traverse drum winding. With end unwinding webbed cheeses should have best ends on top.

Rabbeth Spindles.

Self-contained rabbeth spindles may be used in vertical spindle winding frames, to hold ring-frame bobbins for side unwinding, and it is possible to apply a zig-zag drag band against each spindle, the band running from end to end of the frame and being easily tightened.

For very many years indeed, plain spindles have been used to hold the flanged warper's bobbins built up on this winding frame, the bobbins resting upon a large metal ring by their own weight, and possibly flannel washers used to give enough bite and drive to the bobbins. Rabbeth spindles may be used for this purpose also, and will run two or three months without oiling, although greater in first cost.

Size of Knots and Methods of Folding.

When required to wind and double more than 3-folds it is inadvisable to wind many folds in one process, partly because the knot dimensions are too great when making bunch piecings.

For example, in making a 4-fold sewing thread it is much better to make 2-folds and then place two of these together in the creel of the twisting frame. In this way smaller knots are obtained, in addition to obtaining the other merits of cabling, in regard to better balance of thread, greater tractability, nicer appearance, and softer stitching effect.

Extending this to the limits of 12-fold, the breakages would be mostly in the 2-folds, in which each knot would be only $\frac{1}{6}$ the size of a knot of 12-fold.

In making 15-cord netting, good results may be got by conbining three 2-fold yarns with three 3-folds, there being some colour distinction in the empty bobbins.

In making 6-cord it is supposed the best effect is obtained by making 2-folds, and then twisting three of these together. Sometimes, however, 3-folds are first made and then two of these twisted together.

Strong nettings may be from 21-fold and may be composed of 3 threads of 3-fold plus 3 threads of 4-fold, or else 7 3-folds. Some make a proportion of 2-folds to get smaller knots, and these will readily face large needle eyes that are used.

For such purposes as healds, netting, sewing-thread and similar effects with a high number of doublings the cabling effect, or two doublings, "ppg and Fin" are advisable.

When many folds are wound together at one process, and any piecings are required, the general tension of the threads may be detrimentally affected.

Bottle Bobbins.

These find their chief acceptance, perhaps, in the case of making bobbins for the creel of gassing frames in which the troubles of short length creel bobbins and stoppages are greatly accentuated by the more or less faulty gassing when the frame or when individual front cheeses are stopped and started too frequently.

The bottle bobbin motions permit a frame of the vertical spindle type to make either bottle bobbins or double flanged bobbins just as required, and only a minute or two may be required to change from one kind to the other.

Bottle bobbins are suitable for cases in which long lengths of yarn are wanted on the same bobbin and may be suitable for double-double hanks, Grant reeling, or for high speed gassing frames.

Some firms are opposed to winding two ends together at the doubling winder when the single yarn counts reach from 110's to 140's, an exception being very soft twisted material which will scarcely stand the varying cop speeds when twisting from cops at the doubler.

Fine 2-folds are yet often doubled and twisted directly from cops, but to a diminishing extent, low speeds permitting this.

It is quite different in the case of fine 3-folds, in which it is difficult to get good work without much waste from direct doubling and twisting. The doubler winder with single end stop-motion shows to advantage strongly in the case of 3-folds. Better and more work is then got from the twisting frame.

Disc Winding.—The ordinary conical cup pirn winder has been a favourite method for many years, but very firm weft cops are now sometimes produced on special winding frames with copping motions.

The disc winder is not very adaptable, and is another method of pirning or re-winding spun yarn into cops or bobbins for the loom shuttle.

Each pirn is held by its spindle in contact with the bevelled edges of suitable discs. Swivel points are made between spindles and heads, free to lift in brackets arranged over the discs. Upper spindle bearings with inclined grooves upon the upper surfaces are fixed to each spindle vertical, and a pirn head is in rolling contact with a disc.

Spindle and pirn move upwards as in a pirn winder until the pirn is long enough, when automatic disconnection occurs. The

discs and pirns have a varying rate of revolution, so that the winding rate of speed shall be much the same for all diameters of cop cone. Some people consider the disc winder will give a harder pirn than the cup machine, and will also wind softer yarn with limited yarn breakage. For large hosiery bobbins disc winding may have the empty spool driven from large diameter of disc and full bobbin from small diameter of disc.

Main Driving.

A knowledge of main driving is very important to mill officials, and, along with driving from line shaft to machine, belongs to all parts of mill. There are mainly four methods of transmitting the power from the first motors of cotton mills to the shafting and machines. These four are : (1) wheel gearing ; (2) rope driving ; (3) belt driving ; and (4) electrical driving. The first mentioned is the oldest, and the last is the newest method. Formerly wheel gearing was the method in general use, but for many years hardly any English spinning mills have been fitted with wheel driving, and the system appears to be rapidly growing obsolete on account of noise, dirt, and liability for expensive breakdown. It is naturally a very positive drive. Belt driving never attained to any degree of popularity for cotton spinning mills, although a very limited number of mills with such driving have been successfully working for many years. Some new English spinning mills have been equipped for electrical driving, and there is now every probability of this much-discussed system having a thoroughly fair trial. Recently the present writer inspected one of these new mills, and was astounded at the character of the equipment and its apparently effective working. The mill started, and is running most satisfactorily, and early began to pay a dividend ; but the manager said he would scarcely advise the electrical drive unless there was an ample water supply, which they had themselves. Rope driving is the most favoured system of main driving for English cotton spinning mills, only a limited number of modern mills having any other kind. Since about 1880 this system has been greatly in favour, although it was introduced really about 1860. All circumstances considered, it is deemed to be cheaper than any of the other three methods, and it gives a quiet, steady drive, which has proved itself much better than the variation of the belt system or the noise of the wheels. It lends itself rapidly to changes of machinery, and is almost absolutely free from breakdown. If a rope unravels or gives way in working hours it can readily be done without until it is convenient for making good. Ring-spinning and ring-doubling frames lend themselves conveniently to direct motor driving.

Corkscrewed Yarn.

Corkscrewed yarn is a special defect of doubled yarn, being almost as frequent and as likely to occur in doubled yarns as bad ends and snarls are in single yarns. Corkscrewing is very generally the result of doubling slack and tight threads together, since the slack threads will appear more or less wrapped round the tighter ones in the form of a screw. It will be evident if one out of three threads that are doubled together becomes slack the strain will devolve on the two tight ones, and therefore both the appearance and the strength of the doubled thread will be appreciably diminished. If one thread be finer than the others, or if it come too freely off the skewer or bobbin, there is a likelihood of corkscrewing. The use of the doubling winding frame, equipped with detector wire stop-motions, has a very beneficial effect in preventing corkscrewing, and also another great evil in doubling, viz. single.

Yarn Conditioning.

Conditioning of yarn on some definite system has become a recognised practice, and most descriptions of yarns are subjected to this process. Originally, yarn was often conditioned in one way or another by the consumer of the yarn, as, for example, the present writer worked at a spinning and weaving firm where the weavers used to regularly dip their skips of weft into clean water, or else pour water from the well upon the weft in the skip. Properly conditioned cotton yarn will usually weave or wind better, with less tendency to run into snarls than if unconditioned. The practice having been now well established, it will be understood that if a spinning firm sent yarn away without any conditioning, it might be a great loss to them, since yarn is sold by weight, and 4 or 5 per cent. of conditioning has become a more or less customary thing. As to how long it takes yarn to become properly conditioned will depend largely upon the method of procedure. In the case of an ordinary damping cellar, in which the skips of cops rest upon rows of bricks, with water passing between the brick rows, and with no special means for accelerating the conditioning, it may take about one week. In some cases, however, humidifying installations help to hasten the conditioning, and in Pearson's system the cops are placed between damp sheets, while in yet other cases water is degged on the cops, and all these special methods help to reduce the conditioning period.

Dipping ring bobbins in a water tank is a quick method, but the empty spools should be enamelled.

In some winding frames the yarn is guided over a wet roller.

Cone Winding Features.

In winding cones on the drum winder the small and large ends make equal revolutions per minute at any given time, so their surface or winding speeds must vary greatly, or in proportion to the difference in diameter between the two ends at any given moment. The traverse maintains a uniform rate.

Arising from this feature such questions as the following may be suggested:—

1. Which part of the cone width agrees best with the surface speed of the driving drum, and takes the greater part of the driving effect?

2. The surface speed of the driving drum must differ from that of most parts of the cone, and it has been suggested that this may chafe the yarn somewhat.

3. Perhaps the most important practical question is that concerning slack or tight winding due to the varying diameters, since with varying diameters in the cone width there must be variation in yarn wound-on, but yarn drawn primarily from the creel by the thick end of cone may be thrown by the quickness of the traverse motion to the lower winding speed of the thin end, tending to give a soft nose to the cone.

4. Because more yarn is going on the thicker end of cone, the pitch of the spirals may vary somewhat.

In spindle winding with quick traverse, both the winding-on rate and the diameter increase equally, and this maintains equality in the pitch of spirals.

If poor yarn required a reduced winding speed, the traverse rate might also need reducing to maintain the exactness of coils per width of cheese.

Slow Traverse Drum Winder.

At one time it appeared that quick traverse drum winders would entirely displace slow traverse drum winders.

Experience has shown that the slow traverse, with its flanged bobbins, is yet preferred by some people, even for doubler winding.

A modern machine may wind at the rate of 120 to almost 200 yards per minute, two or three ends up, a girl minding from twenty to thirty spindles.

The Brake: Close Setting and Double Movement.

In stop-motion doubling winding frames it is important to stop any bobbin very promptly indeed, to prevent a broken thread from going too far and requiring to be found. This thread-finding is

helped materially by carrying each thread round light, high placed bowls before passing to the drum.

There is a brake for each bobbin or cheese, and this must be set quite close to the cheese for prompt action. It is desirable—and in some cases obtained—to have the brake set quite close to the empty tube, and to automatically recede as the tube or cheese increases in diameter, the brake at all times being very near to the spool.

A fixed brake would be farther from its work for empty tubes and nearer for full ones.

Failure of a thread drops a detector wire, which sets going the lever system for dropping the cheese away from its drum.

In some cases a double brake action is obtained by which the brake moves towards the cheese as the cheese moves towards the brake, giving a double action which very promptly stops the cheese.

Winding Costs.

Cop winding on vertical spindle winders is one of the simplest operations in the cotton trade, and is done in spinning mills, in doubling mills, or in weaving mills just as may be desired in any particular case.

A girl or woman possessing aptitude and deftness of hands will soon learn cop winding. It is a clean operation usually carried on in a comparatively quiet room. Many winders obtain very moderate wages, and yet the labour cost of cop winding to a firm is very high per 100 lb. of yarn. Taking a basis of 100 lb. weight, the labour cost on almost any one process in cotton spinning is lower than that for winding, taking 20's/36's as a basis.

The Climax Doubling and Winding Machine.

At the time of writing some attention has been attracted to the machine known by the above title. It has been described as an "up-twisting machine" and has new features sufficient to command patent rights and separate claims.

For certain sorts of doubled yarns it is claimed to dispense with the ring or flyer doubling machine.

Doubling or twisting and winding are performed at the same time. The desired number of ends having been previously wound upon a cheese, bobbin, or cone, the package is placed upon a spindle driven from a tin roller so that the yarn is drawn upwards over the end of a revolving spindle, over a pivoted drum, and then downwards on to a bobbin or drum wound cheese which is ready for a warper's creel or other commercial use.

The frame is not stopped for doffing purposes, as either creel yarn or produced cheeses of yarn are each independently controlled.

It will be understood that no flyers, rings, and loose rollers are used.

It is possible that a machine of this character which twists without using either ring, flyer or twiner doubler will find opponents, and there may be sorts of work difficult for it to do.

The maker's claim it will give uniform twist.

The employment of a single tin roller with band arranged to drive a spindle on each side of the frame, ensures against slack bands, as they are automatically kept taut whilst at work. The life of the bands is increased substantially. A simple arrangement can be supplied so that the tin roller can be reversed without changing spindle bands.

It is claimed by the makers that any desired twists from 1 to 50 per inch are obtainable and for which a suitable range of change wheels can be supplied, giving any determined ratio of spindle revolutions to one of the drum. Each side of the frame is separately controlled so that different turns can be put in yarn on each side if required.

The spindle used is of the self-contained flexible type made by a firm of repute.

The carriage in combination with a lever arrangement forms a take-up motion which prevents the occurrence of slippage during the winding on, the contrivance automatically adjusts itself to the conditions of gradual increase in the diameter of the bobbin spool or cheese being formed.

The frame can be adapted for either requirements in doubling.

For 5 inch traverse cheese (basis) the gauge is 6½ inches.

To find length, multiply half the number of spindles by the gauge, and add 3 feet 3 inches for gearing and outends. The width of frame is 3 feet.

Approximately 3 B.H.P. per 120 spindles.

Nett weight, approximate, 2½ tons per 120 spindles.

Winding for Hosiery.

It is not necessary to enter into any description of the process of knitting, or the mechanism of the knitting machine. It is important for the spinner to know what a hosiery manufacturer requires when he places an order for single yarns to be delivered to the said manufacturer on cones. The hosiery trade has very greatly increased during recent years, and is continually increasing, owing to the ever-increasing custom of wearing knitted goods next the skin, and also to the use of knitted goods in preference to woven ones for many other purposes. Generally speaking, the twist constants for yarn required for hosiery purposes are very low, owing to the usually soft nature of knitted goods. Moreover, a good

quantity of yarn is often wanted on each individual cone intended for use at a knitting machine, as there is generally ample creel space at the knitter, and it is suitable to have end unwinding from large sized cones, which give few thread piecings, and last a long time at the knitting machines. The continuous productive capacity of a knitting machine is an advantage over the intermittent operation of a loom in weaving.

Many spinning firms have erected winding frames largely for the purpose of meeting the requirements of hosiery manufacturers, but for one reason or another many hosiery people prefer to do their own winding. Winding frames for one thing are almost more appropriate to the female labour and general surroundings of a hosiery manufactory than the conditions of a spinning mill. The fact remains that spinners are, more or less, frequently asked to supply yarn on large cones to hosiery manufacturers.

Experience appears to have demonstrated, on the whole, that cones wound on the spindle winding frame are more likely to suit hosiery people than cones wound on the drum winder, although both machines are actually used for the purpose. Although the spindle winder gives a variable winding-on speed, yet it gives a uniformity of spiral or thread crossing that helps to produce firmly built bobbins, even at the thin ends of the cones, and this helps to give a uniform delivery of yarn from the cone at the knitting machine. Such excellence in the build of bobbin, especially at the thin end of cone, appears more difficult to get from the drum winder. Uniform delivery of yarn at all points, from start to finish of the cone, is even more essential at the knitting machine than at most other processes. It is necessary to have uniformity of yarn delivery and of yarn tension, or otherwise the required taut interlacing of the threads may be interfered with.

It is also very important that all slubs, bad ends, thick places, bits of seed, leaf, or any other impurities must be cleared out, and the difficulty of doing this is enhanced by the soft twisted nature of the thread, and the necessity for avoiding the rubbing up of portions of the thread. Iron clearer plates of the well-known Suggitt type, with adjustable apertures, are probably the most suitable for the purpose, when everything is considered. There is so much space on the knitting machine for large bobbins that it is often required to have eight or nine cops wound upon one large cone for the knitter. The diminishing angle of the thread upon a drum wound cone tends to give a more loose delivery from a full cone than an almost used one. It is well known that good conditioning helps to make a yarn solid and tends to prevent curling, snarling, winding off too freely, and too much liveliness generally. This is even more true in regard to yarn for knitting purposes than for many other yarns, and this conditioning is

naturally much better done in the cop form than after winding upon cones.

In summing up the features relating to this important business question, we should therefore specify the following features :—

1. Cones built upon the spindle winder are probably the most likely to work well.
2. Clearers of the adjustable metal plate type are very suitable.
3. Hosiery yarn is usually soft twisted.
4. Well-conditioned yarn before making the cones is likely to give most satisfaction.

Cotton Waste Yarns for Hosiery.

For the hosiery trade generally the best classes of cotton waste condenser yarns are often wanted, although coarse, cheap, half-hose, or socks are often made from moderate qualities of preparation yarns.

A good deal of comber waste and good strips may be used.

Sometimes hosiery goods are unions of cotton and woollen in which possibly one-fourth of the total weight of yarn in the knitted products consists of yarns from worsted or woollen wastes, and in order to give fullness or softness, and to justify the trade designation of union goods, although the other four-fifths of the yarn may be from low counts yarn, from cotton waste or American cotton. In August, 1922, the author examined men's cotton socks offered retail at 6d. per pair, made in Japan, and sold in a Lancashire town.

For hosiery purposes finer counts and greater strength may be wanted in low counts yarn than for cotton blankets or quilts, and therefore preparation yarns are sometimes preferred although not so soft and full as condenser yarns.

Many hosiery garments are made in which there are combinations of ordinary cotton yarns, cotton waste yarns, and woollen or worsted wastes, the proportions of each material and manner of blending varying with local circumstances. Sometimes the wool reaches only 2 or 3 per cent. chiefly to justify the statement that wool or worsted does enter into the fabric.

Testing and Judging Purchases of Yarn.

The most essential test of all is that for counts, such a test being the basis of tests for other purposes. There are many purchasers of yarn who have various ways of judging their yarn for other purposes, so long as the counts are correct. Naturally the yarn would be weighed in the gross upon receiving same. As soon as convenient a number of cops would be taken to the

wrap reel, and possibly four at a time may have a lea each reeled off. By comparison with a table or by a simple calculation it is found from these leas of yarn whether the yarn is of correct counts. If, for example, the yarn only wraps 38's instead of 40's, we may be receiving the correct gross weight, but we are distinctly short of length, and we are paying the price of 40's yarn for 38's.

Next in order of testing may be placed the strength test. Each lea of yarn after reeling off may be placed between the hooks of a lea testing machine, driven either by hand, or more preferably by power, to determine its strength. Every mill has, or should have, some strength standard, and approximately correct tables of strength are published in one place or another, so that a comparison should be easily made. In some cases it is deemed preferable to test single threads of yarn for strength instead of depending upon the lea test. The ordinary lea tester is supposed to give also some indication of the stretch or elasticity of the yarn at the same time as it shows the strength.

Suppose in testing a lea of yarn for strength the lower hook moved 3 inches downwards while the upper hook only moved 1 inch before breaking point was reached, then the difference of the two, or 2 inches, would be taken to represent the stretch. Many mill officials have for the most part contented themselves with testing for strength and counts, but during the last few years there has been a tremendous increase in testing for moisture by the aid of specially constructed ovens. These ovens are convenient for quickly testing small quantities of yarn. A small quantity may be placed in the oven inside a proper receptacle forming one end of a pair of scales, the other end of this balance being fixed outside the oven. The yarn is weighed upon placing inside the oven, and again after remaining inside for some minutes. The oven may be heated to possibly 220° F. or so, kept as nearly uniform in temperature as possible, and the yarn left inside for possibly three-quarter hours or so, although opinions differ somewhat in regard to temperature and time of exposure. A simple proportion calculation will show the percentage of moisture extracted, and it must be remembered that somewhat less than 8 per cent. is natural to the cotton when we are reducing the sample to an absolutely dry condition.

For better or worse, oven testing of raw cotton and cotton yarns appears to be distinctly increasing. Occasionally single yarns are tested for twist, but this test is more convenient and necessary for doubled yarns, and if single yarns are suitable in counts, strength, and moisture, we need not as a rule trouble much about twist per inch. If a good class of single yarn is in question, it will probably be best to make an examination or inspection of the yarn with a view to determining the relative proportion of dirt, bits of leaf,

snarls, nep, thick or thin places it contains. One of the best methods of doing this is to fix up a cylinder—something like an old carding engine doffer—so that it can be slowly turned, and so that it is equipped with cop skewers and a traverse guide for the yarn.

The threads from several cops may be simultaneously wound side by side on this machine, thus revealing any such defects as those just pointed out. One yarn may also be readily compared with another, when they are wound side by side on such a machine. Many purchasers of yarn prefer to wind small samples upon the black boards of possibly 12 or 18 inches length, which show up yarn defects reasonably well, and are convenient for storing away for reference, or for sending away to yarn sellers when complaints are being made. In keeping a complete record it would be advisable to head several columns by the several terms of day, month, year, details of order, correct counts, ascertained counts, strength, stretch, moisture, and details of yarn defects as revealed by the inspection.

Ball Drag v. Flannel.

Ball drag has superseded the knee board covered with flannel or listing in a good number of mills during recent years, and the makers referred to in a previously given figure, have taken a strong lead in this direction. However, although the flannel does tend to destroy the nap from certain yarns, many people yet prefer it—especially as it is so very adaptable to different tensions and sorts of yarn. The ball-bearing drag may consist of a porcelain slotted cup containing a ball of steel or other material.

Ball drag is clean, rather easily applied to existing frames, requires little expense in upkeep, not likely to injure the yarn, but it may require different weights of ball for different ranges of work, although the same balls may serve over a fair counts range, especially if the height of ball can be altered.

The method of tensioning yarn on winding or other frames by threading it under a glazed ball has received considerable adoption of recent years, both in England and in other countries. The yarn may be very readily threaded—in some cases it is almost self-threading—a different size of ball may be used for different tensions; the balls do not gather fly or dirt; it is easy to make suitable sockets or bearings for the balls; the arrangements are extremely simple and durable.

Efficiency Clock.—This clock may have a clock face and fingers much the same as an ordinary clock, but the fingers are controlled by some regularly working part of the machine. If, for example, a machine never stopped in the afternoon until 5.30, the clock

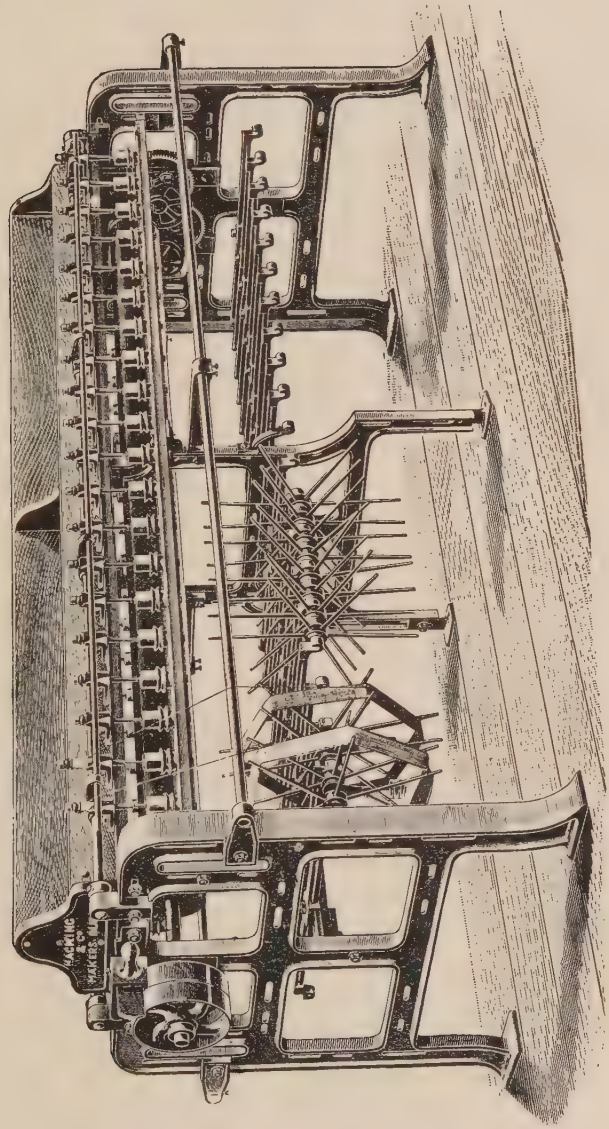

FIG. 30.—Cup pirn winder.

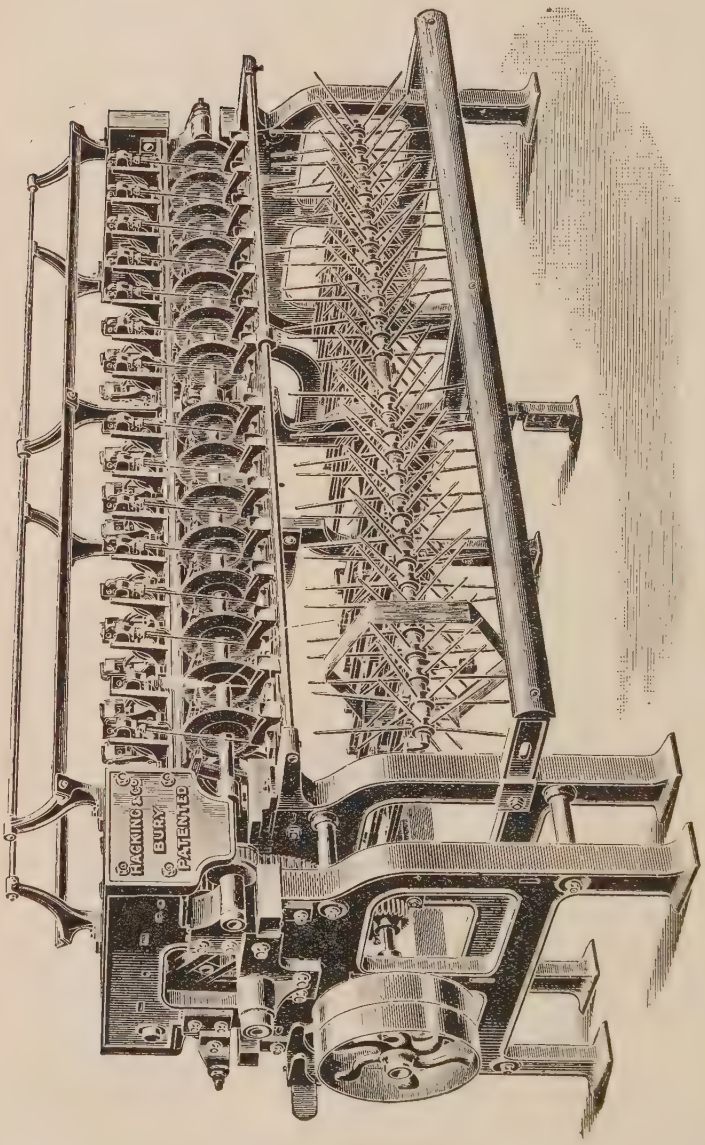

FIG. 31.—Disc winder.

would show 5.30. A loss of half an hour would leave the indicator showing 5 o'clock. This kind of indicator is not much used in Lancashire.

Cup Pirn Winder. (Fig. 30.)

This machine is adapted for winding grey or coloured yarn from hanks on to wooden pirn bobbins, or on to paper tubes. It can be fitted with ryces or bird cage bobbins, placed either on the top or bottom of the machine for either linen or cotton. The machine is made with steel spindles, and cast-iron cups to form the pirn, and is supplied with improved heart traverse motion, cast-iron turned and polished wharves with steel slots, and with tension rail; tin driving cylinder 6-inch diameter, polished pirn stand, and fast and loose driving pulleys 10-inch diameter.

Disc Machine.—This machine is provided with conical discs which drive the pirn by means of rolling contact, thus avoiding the friction caused by stationary cups or revolving cones. The driving is differential and adjusted to the varying diameters of the pirn cone, so that the yarn is wound regularly without shocks and the hank rotates at an uniform speed. This enables a greater amount of yarn to be got on the pirn without increase of size, and the breakages of yarn during winding are much reduced; best steel spindles, spaced 5½-inch gauge, ryces, ryce carriers and drag weights, polished bobbin boxes, tension rail, fast and loose driving pulleys. The disc machine may be used instead of the pirn winder. (See Fig. 31 for disc winder.)

Some Uses of Yarns.

A very large amount of yarn of good quality spun from Egyptian cotton, both combed and carded, is made into sewing thread, and such yarns require the maximum strength and uniformity consistent with the reasonable amount of twist found best in yarns for doubling. For lace purposes fine 2-fold yarns, gassed and probably prepared, are very frequently required, and the doubling weft yarn suitable for this purpose requires the utmost attention in order to get sufficiently good spinning with a small amount of twist. Snarls, bad ends and uneven yarn are grave faults in such yarns. Warp and weft yarns spun from American cotton are used to a tremendous extent in weaving a great variety of cloths from plain calicoes in narrow looms, up to good twilled sheetings, and many cloths made fancy by colour or special weave. Such yarns are much cheaper than those for lace and sewing thread, and less care is often exercised in their spinning, single roving being deemed good enough at the spinning

machine. A large proportion of yarn spun in England is exported to other countries, extra hard twist going to Turkey and Asia Minor for weaving into their special goods, while both moderate and good qualities of yarn are exported to the Continent. Good warps for the Bradford trade, many varieties of doubled yarn and the great variety of uses account for much of the cotton yarn. A good quantity of Bolton fine yarns goes to Saxony for the manufacture of fabric gloves.

CHAPTER III.

WARPING.

Warping succeeds winding, and consists essentially in assembling together a large number of individual threads into one group, usually as a first step towards making warps for the loom.

A weaver's warp consists of a large number of parallel threads assembled in sheet form, and wound in long lengths around a wooden or metal beam.

The well-known methods of warping consist of (1) beam warping, (2) mill warping, (3) sectional warping, (4) chain warping, (5) cross-ball warping.

In the cotton trade at any rate beam warping is the most used since it is the accepted method for grey goods.

A beam warper may assemble together in sheet form possibly 500 separate and very long threads, and wind them upon a very wide beam.

At the slashing or sizing frame several of these warper's beams, 4 to 8, may be placed in a suitable creel, combined into one narrower sheet, passed through the sizing process, and assembled as one sheet or warp upon the weaver's beam. There may be from 2,000 separate ends or threads in a plain narrow weaver's warp up to four or five times that number in wide fine warps; several thousands of ends according to kind and width of cloth. A poplin contains very many warp threads per inch, and a 30-inch wide poplin of 144 ends per inch represents 4,320 ends.

A patent satin quilt 100 inches wide and 100 ends per inch, represents 10,000 warp ends going into the cloth, but these are composed of two separate warps, each of which is again subdivided into two warps placed end to end.

Ball Warping.

Used now mainly for coloured goods, but is an old form of warping machine described by Dr. Ure about 1850, and not much altered in principle since that time, but is improved in certain details.

The creel for the warper's bobbins is perhaps more often of a

half-moon or semi-circular shape, but can be of the V-type if required.

The warping mill itself is practically a gigantic reel arranged vertically and made of various circumferences all the way from 9 yards up to 20 or more, the following circumferences being well-known: 12, 14, 15, 16, 18, or 20 yards each. The depth or vertical length of mill staves from 6 feet to 8 feet as ordered. Any such warping mill may be fitted with reversing pulleys for power driving; and also a handle for hand turning, a yarn speed of 150 to 170 yards per minute being obtainable. Production may be 35,000 hanks per week of forty-eight hours of 28's to 32's warp yarn. Less than 1 horse power per mill required, and men warpers belonging to a rather close union are employed.

Warping Mill.

A warping mill is a very simple machine, capable of either power or hand-turning, and having an extensive vogue in the coloured cotton goods trade, forming a part of the equipment of either the spinning or the weaving mill.

A warping mill is practically a huge reel reaching up to a maximum of about 8 yards diameter or 24 or 25 yards circumference in the very largest sizes, down to 2 yards diameter in the smallest, say 25 yards circumference in the largest, down to 6 yards circumference in the smallest.

1. The creel to hold the bobbins may be curved or semi-circular in shape.

2. The heck contains a wire guide or eye for each thread and divides the threads into two sets.

3. The mill or reel itself takes the yarn from the heck, the yarn being collected in rope form after leaving the heck and wound spirally upon the mill from top to bottom and vice versa. *Length* of warp depends upon diameter of mill and number of coils or spirals top to bottom; *ends per warp* depend on number of times the rope of yarn is taken along the length of the mill and ends in creel. The mill is built around a central shaft which has its foot bearing or bracket fastened to the floor and is supported at the top by extended iron arms to anything convenient. Several cross-pieces are clamped to the vertical arms, and each cross-piece usually contains two pegs round which the loose rope or chain of threads is carried. Occasionally a clamp contains only one peg for reversing purposes.

The gearing for driving the mill permits hand turning or power driving in either direction as required.

Mill or Ball Warping.

In the mill warper the principal parts of the machine are the creel, the heck, the mill, and the reversing motion.

The mill is really a gigantic reel mounted on a vertical axis mostly reaching from 12 to 20 yards in circumference or more. At the foot of the vertical shaft of the mill may be fitted a bevel wheel driven by another bevel on a low cross-shaft. This shaft is operated from the headstock or pulley shaft, and in this way the mill may either be rotated by hand or by power, first in one direction and then the other, the gearing forming a reversing motion.

The creel is usually a vertical curved framework arranged to hold the bobbins in a horizontal position. The half-moon creel is customary, the V- creel being seldom required for ball warping.

The heck is between the creel and the mill. It consists of a long box or frame containing a good number of polished steel eyelit pins, these being for each thread to pass through. Besides assisting to guide the threads properly upon the mill the heck greatly assists in forming the lease. The heck is in two parts, and by pulling at the proper handles the threads are divided into two sets, and either one set or the other can be thus placed in the lower or higher position. The lease thus formed is preserved by proper pegs and tying up on the mill itself.

By the "lease" is meant the alternate separation of the threads, in order to facilitate the finding of the threads in the succeeding processes. There may be up to 500 bobbins or more in the creel at one time if necessary, reaching down to half that number in some cases.

The threads from the creel bobbins are passed through the heck box, and then gathered together in a loose rope and attached, say, to the top of the mill. The latter is revolved so as to wind the rope of yarn round the mill, and the yarn is wound on in a spiral form by the descent of the heck at a definitely regulated speed.

When the yarn has been wound sufficiently low down on the mill the latter is reversed and a second layer of threads wound over or between the first one.

The process is repeated a sufficient number of times to give the required number of threads for the warp. Suppose there are 400 bobbins in the creel, and 1,600 threads are required in the warp, than 400 × 4 would mean 1,600 threads in the warp, obtained by four reversals of the reel. The length wound on the mill during one up or down motion will represent the length of the warp, and will depend upon the circumference of the mill and the number of revolutions during the lift.

When finished the warp is wound off and formed into a large ball, and balling is one of the most important duties of the warper.

Sometimes chain-warps of yarn are made in preparation for dyeing.

The terms "beer" and "porter," sometimes used in connection with warping, have been probably derived from the "porterage" or "bearing" of the yarn formerly necessary in very old systems of warping, the word "beer" in England being synonymous with the word "porter" in Scotland.

The yarn is guided principally by the motion of the heck box, which receives its traverse from the central shaft of the mill by means of a suitable train of wheels and a rack and pinion arrangement.

The weight of the heck box on the principle of a hoist is counteracted by a balance weight attached to it and hanging over a pulley. Naturally the reversal of the mill compels the reversal of the heck.

Dr. Ure, on Mill Warping.

It is remarkable how little the process of ball warping on the large warping mill has altered since 1830. The accompanying Fig. 32 is taken from Dr. Ure, and his description is reproduced *verbatim*. Dr. Ure says :—

"The bobbins are mounted loosely on spindles on a frame, so

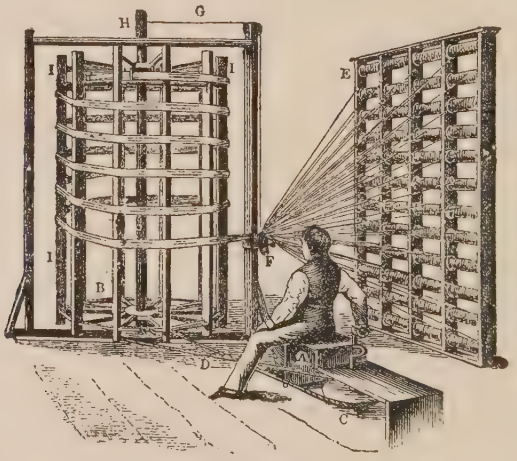

FIG. 32.

that they may revolve and give off the yarn freely. The warper sits at A and turns round the reel, B, by the wheel, C, and rope, D. The yarn on the bobbins is seen at E. The slide, F, rises and

falls by the coiling and uncoiling of the cord, G, on the shaft of the reel, H. By this simple contrivance the band of warp yarns is wound from top to bottom, spirally, round the reel. I, I, I, represent wooden pins similar to those used in peg warping. Most warping mills are of a prismatic form, and have twelve, eighteen or more sides. The reel is usually about 6 feet in diameter[1] and 7 feet high, and serves to measure accurately, on its circumference, the length of the warp. It may be turned either way by a rope moved by the trundle, C, which is actuated by the warper's hand.

"At E is the frame to contain the bobbins, the threads from which pass through the heck placed at F. This now consists of a number of finely polished and hard-tempered steel pins, with a small hole at the upper part of each to receive and guide one thread. The modern heck contains two parts, either of which may be lifted by a small handle below, and the eyes of each are alternately placed. Thus when one is raised a vacancy is formed between the threads, and when the other is raised the vacancy is reversed. By this the lease is formed at each end of the warp, and this is preserved by appropriate pegs. These being carefully tied up give the rule for the weaver to insert his rods. The warping mill is turned each way successively until a sufficient number of threads are accumulated to form the breadth wanted. The warper's principal care is to tie immediately every thread as it breaks, otherwise deficiencies in the chain would exist, highly detrimental to the web, or productive of great inconvenience to the weaver. The box which contains the heck slides on an upright rod as shown in the figure."

Modern Description of Mill Warping. The Gearing.

Hereafter is a description of one warping mill the writer is very familiar with.

The gearing consists of pulleys, wheels, and shafts arranged for either hand turning or power driving. On the top of an upright gearing shaft is a handle the correct height for a man's hand.

At the bottom of the shaft is a bevel wheel driving a second bevel wheel on a cross-shaft which reaches under the mill to make contact with and give motion to a very large bevel wheel fixed on the lower part of the vertical axle shaft of the mill. By this connection the mill can be revolved either one way or the other by hand.

Centrally placed on the upright gearing shaft is a bevel wheel gearing with a bevel on either side of it, each of which bevels is coupled to a separate driving pulley, there being a loose pulley be-

[1] The warping mills in use now are generally much larger than this and usually fitted up for power driving or hand working as desired.

tween the two fast ones, and the three pulleys and two bevels being all disposed on the horizontal pulley shaft. The machine is stopped when the driving belt is on central pulley. When belt is on inside pulley, the long pulley sleeve carries also one of the bevels and is loose on shaft, and in this way the upright shaft is driven and consequently the huge warping mill.

When the belt is on the outside pulley the pulley shaft itself revolves and therefore also the opposite bevel which is also directly fastened on the shaft; with the result of revolving the warping mill the opposite way.

Even if all the bevels remain always in contact no harm results, but some of the parts revolve contrary way alternately.

The Heck.

The heck is supported cantilever fashion from the vertical heck post, and in this instance a chain passes upwards from the heck, over guide pulleys at the top and has then a balance weight suspended from it and held in a vertical trough path so that the weight almost fully balances the heck. A thin rope helps to keep the heck and weight straight from the top of the mill shaft, a cross-shaft is driven by bevel wheels, and this shaft reaches over the mill to the spur wheels of the heck-chain guide pulleys, so that the rotation of the mill winds the heck up or down according to which direction is required.

The heck wheels can readily be temporarily disengaged by rods and levers so that the heck can be quickly moved up or down by hand to start in exact position on the mill. There are other methods of driving the mill and the heck, but one description is sufficient here.

The threads from the creel pass through the eyes or needles of the heck—half in each set of needles—they are then somewhat condensed in passing between vertical porcelain guides, and immediately condensed again to pass as one loose rope between a special pair of vertical porcelain guide fingers. The wire eyes are level when working, but for leasing purposes either one of the two sets may be pulled to the top by a special handle.

There are two cross-bar clamps towards the top of the mill and other two towards the bottom. The clamps are of hard smooth wood, each shaped to neatly clip two of the vertical mill bars, and readily adjustable by means of a wing-nut and screw.

For the longest warps the cross-bar clamps are placed nearly at the top and bottom of the mill, but for shorter warps the clamps are moved just as much nearer to the middle of the mill as may be needed.

Method of Using.

Starting with the top clamps the heck is placed directly opposite these clamps, the loose rope of yarn is conducted round the pegs of the clamp and suitably knotted so that the yarn is firmly held attached to the mill. Starting gently the mill is then fully set going, and the rope of threads is wound in a mild spiral round the mill, the spiral being due to the slow traverse of the heck. The large diameter of the mill causes the creel bobbins to revolve very rapidly. The number of rounds are fixed according to the length of warp required having full regard to the circumference of the mill. The ends of the warp are now secured round the pegs of the lower clamp.

The mill is then reversed in direction of rotation so that the heck ascends, and a second round of warp is laid on the first one until one gang or double traverse is effected. Supposing there were 200 ends or bobbins working in the creel there would now be 400 ends in the warp, and if 1,600 ends were wanted in the finished warp there would need to be four complete return journeys of the heck. If the warp were to be, for example, 1,000 yards long and the mill 20 yards circumference, the mill would make 50 revolutions one way before reversing.

At the heck the odd numbered threads pass through the wire eyes of one portion of the heck, and the even threads through the wire eyes of the other half of the heck. By raising each half in turn two sheds are formed, kept apart by finger and thumb, and passed round the clamp pegs so that even threads pass under one peg and over the other peg, while odd ends pass under and over in the reverse order.

The chain which sustains the heck on one side and the balance weight on the other is also connected to a screwed horizontal rod extending across the width of the heck. By a wing nut and screw on the rod, the heck may be lowered or raised to any small degree and to an extreme amount of about 3 inches, in order to get absolutely exact position of heck opposite the mill, and to quickly and accurately spread the yarn a little on the mill, to minimise the effects of excessive overlapping of one layer of yarn upon another.

Chain Warping.

In the doubling trade, sewings and other yarns which are intended to be dyed are sometimes made into chain warps which have a distinctive character of their own, and put the yarn into a manner suitable for passing through the bleaching and dyeing processes. The chaining machine in some cases may be attached to a beaming machine, the beam being unused for the time being,

unless used as a driving drum for the chaining part. Chain warps are like beam warps in being very long. Chaining puts yarn into good condition for transport, and is much used for single yarns as well as doubled ones. Chaining may reduce the length of a ball warp to about one-fifth in such a manner that bleaching or dyeing liquid may operate effectively on all parts of the yarn.

Sometimes a chaining or linking machine may be attached to the Vee creel of an ordinary beam warper, and one machine may link 1,500 yards per hour. There are, however, other methods of making chain warps. Soft two-folds from combed Egyptian cotton for mercerising purposes are often treated by this method of warping, as well as single yarns for bleaching, dyeing, and transit purposes.

Hand chaining may be done as the loose rope of threads is drawn off the circular warping mill described elsewhere in this chapter.

The loose rope of threads or warp is grasped by first one hand, then the other, loops of yarn are formed until a five-strand chain is obtained. Machine linking or chaining has largely superseded hand chaining. Movements of the hand are imitated, uniformity of links obtained, and the yarn suitably deposited in a box.

A chaining machine is obtainable that will chain a complete warp and may be used either in combination with a ball warping machine, or independently. It is possible to chain warps containing 3,000 ends of 16's to 20's yarn, the warp made in ball sections and chained off a number of these.

A warp laying or cuttling machine is intended for bundling warps after dyeing, bleaching, or equivalent process, and can be arranged for one or more warps.

Cross-ball Warping.

This process is specially adapted for warps that require dressing after dyeing or bleaching. The warp is wound in widely pitched quick coils on a tube placed on a spindle.

It is guided suitably to the roller in a manner which prevents disarrangement of threads or tape. The warp is laid in a continuous flat band or tape over its full length, and is in good form for subsequent processes. The machine may make warps direct from creel through beaming frame with stop-motion for broken ends, and there is a suitable method of taking end-and-end leases and half-beer leases.

Warps may be made up to 28 inches wide and over 300 lb. weight. It may be arranged to make two or more balls at the same time, so that in making warps with only a small number of

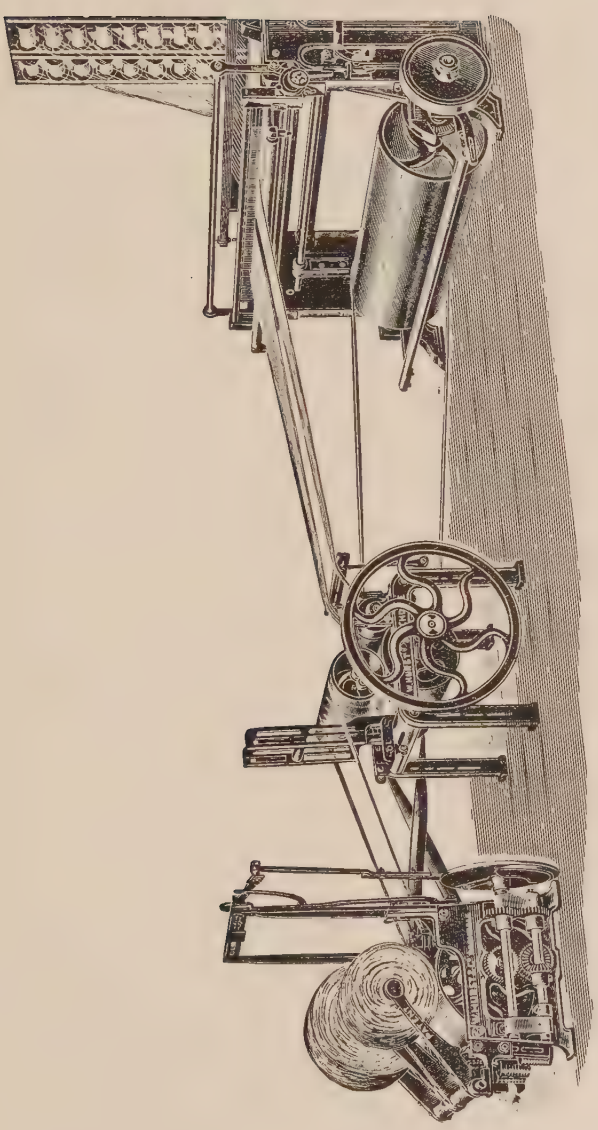

Fig. 33.

threads, there is less danger of breakage of threads when starting the machine.

Suitable for cotton, silk, mohair, worsted, jute, or other textiles.

Hurst's chaining machine for making chain or linking warps has had a good vogue in the mechanical linking of cotton warps.

A warp that has been chained is in good condition for passing through the processes of dyeing, bleaching, etc. When a chain warp is undergoing subsequent dressing or beaming, the threads are usually in proper place since crossing and entanglement of threads or ends is effectively prevented. The machine under notice simplifies the chaining process and reduces the cost. It will make a uniform link, or what is called the "fine strand chain." (See Fig. 33.)

The warp will afterwards unlink readily and maintain the threads in good order. Chains can be made from the creel bobbins directly, or from the beam, or in any other desired manner, and the length can be suited to any requirements. A box may be used to lay the warp in, by means of a pendulum motion, and as it is chained a uniform link is obtained all through the length of warp. The links being uniform, and the machine a double linking one, the warp effectively unlinks in the dyeing process. There is an appliance which enables a thread lease to be taken in a few seconds and as frequently as desired.

This chaining machine may be adapted not only for cotton, but also for the other leading textiles of wool, worsted, silk, jute.

It is possible to have an extra linker to make two chained warps at one time, when making chains of a small number of threads and this reduces the possibility of ends breaking when starting the beaming machine with a small number of ends.

Linked Warping.

When spinning mills in England produce warps for sale, they are mostly beam warps for the grey trade, ready for the slasher sizer, and this line of business has increased with the greater adoption of ring spinning.

When it is intended for warps to be put through some such process as bleaching or dyeing, chain warping is often resorted to.

Chain warps may consist of either single or doubled yarn, and the threads are first assembled into a loose untwisted rope form, all threads being of equal length as in beam warping. In England, at any rate, road transportation by motor, and comparatively close proximity of spinning and weaving mills, warpers beams are convenient for rapid and cheap transit; but for greater distances ball or chain warps offer better transport facilities if yarn is sold in warp form.

The loose warp is of course more convenient for any kind of liquid or equivalent treatment.

Some manufacturers of coloured cloths in various parts of the world dye their own warp yarns in the chain form. This method also suits other people who desire an assembly of threads in a loose rope for one purpose or another. After warping, the chain of threads may be either made into a ball of cylindrical or of round form, or on the other hand it may be put up into a linked chain form. Different forms of ball are in use, the cross-balling process being described in this chapter.

Although ball and chain yarns refer usually to warp yarns, yet it is possible to put up weft yarn in this form for liquid treatment, but weft is mostly put up in hank form for bleaching, dyeing, or mercerising.

A linked chain warp is so arranged that it has the general appearance of an ordinary chain, the linking reduces the length of chain, diminishes the chances of damage in transit, is convenient for subsequent handling, and is very convenient for liquid treatment.

For short warps what is termed the short-chain system is sometimes used, but the long-chain system is very suitable for longer warps. The links or loops are larger in long chaining than in short. Winding, chain warping, bleaching, dyeing, sizing, transference to the weaver's beam, and drawing in, represent successive processes; but in some cases the dyed chain warps are made into narrow beams at the sectional warping frame, before sizing or dressing and drawing-in.

If at any time shuttle weft yarns are put into the form of chain warps for liquid treatment, the proper steps will afterwards be necessary for getting the weft upon suitable cops or pirns, there being several machines now on the market for this purpose.

Occasionally in chain warping—but not often—cut marking threads are tied in the warp at proper intervals.

The Lease Division.

Before the threads composing the warp are gathered into loose rope form the sheet of yarn may be divided, and a lease provided by twine being passed through the threads so as to divide the threads into equal parts. This dividing of the threads or lease making is useful in finding correct threads at later processes. In the case, for example, of a very long chain warp, a lease may be taken every 500 yards or so.

The lease division is of primary importance at the loom in enabling the weaver to immediately find any desired thread. The threads passing over one lease rod may pass under the next one. A warping machine or slashing machine is usually provided with

means for taking the lease conveniently. In ball warping, for example, the eyes of the heck are in two parts or sets, alternate threads taking an eye in one or other of the eyes of the heck. A handle enables one set to be put to the top and the other to the bottom immediately.

A half beer or pin lease gives a sufficient separation of the threads to help their separation at the beaming machine, the threads being separated possibly into groups of four.

It is possible to form bunch-knot leases by taking a lease which divides the warp into possibly five sections as nearly alike as may be conveniently got. The ends of the sections may be tied together where the sections are cut.

Sometimes bands of yarn are tied round the ends of a warp to prevent entanglement during liquid treatment. The old-fashioned frame for hand chaining is sometimes useful for short lengths.

We do not often see the warping reels or horizontal warpers in cotton nowadays, but the vertical mill-warping machine, and the sectional warper are in extensive use for coloured cotton goods. In some recent cases there has been a tendency towards using horizontal warping mills, as being good for obtaining sectional features.

A balling warper in some cases may be just a beam warper with the balling attachment as elsewhere described when the warp is for bleaching or dyeing. Softly-wound cheeses of warp yarn from the drum winder may be subjected to liquid treatment before taking to the warper's creel, and thus dispose of any need for chain warping. The cheeses may also be formed on paper spools very convenient for transport. For hand warping the "creel" and the "woof" are used, being built of either wood or iron. The creel must hold the number of bobbins or spools required. The operator gathers the threads from creel in a loose rope and threads this around the pegs of the woof as required.

Beam Warping.

The object of beam warping is to unwind the individual ends or threads from a large number of bobbins or spools in the creel, assemble all these to make one wide sheet of threads, and to wind the sheet of threads around a large wooden flanged beam. The beam is driven by the friction of a large drum to maintain equal winding-on speed, and the machine contains several detailed mechanisms for helping to perform the work in the best possible manner. Such mechanisms include a measuring motion to record the length of yarn on each beam, a stop-motion which stops the process if any single warp thread fails or breaks, a reed for keeping

the threads separate, an expansion comb, and stop-motion for full beam.

Beam warping is the favourite method of preparing grey yarn for the slasher sizing machine.

The Vee creel is the favourite for beam warping since it permits of a large number of spools or bobbins and ready access to any one bobbin at creeling time, in piecing broken threads, or for other little requirements. The creel holds the bobbins in tiers, and guide rods are used so that each thread may pass forward in its desired straight line in the sheet of threads. Wooden creels with metal, glass, or porcelain steps and guides to give freedom to the spools without snarling of yarn. Bobbins arranged in a horizontal position as distinct from the upright position in the creels of mules, ring-frames and fly-frames. A Vee creel may hold about 500 or more bobbins, half of these in each arm of the Vee. Any smaller number may be used in same creel, and for some purposes still larger creels are in use, holding 700 or more bobbins.

Following the natural shape of Vee creel the threads come off from the outside of the wood creel, the narrow end of the Vee giving the centre threads, and the threads spreading out on the arms across the width of beam.

Beaming, Warping Machine Tiers.

Referring to Fig. 34, the machine contains a self-stopping motion on the Singleton principle, and a brake motion is applied to ensure prompt stoppage when an end fails and the stop-motion acts.

The pin rollers are positively driven in this case, consisting of a sleeve connected with the driving pulley and dispensing with one of the frictions on the drum shaft.

The pin rollers are independently mounted in this example, and are so arranged that each end of the knocking-off roller can move independently, so that when a pin drops it is not necessary for it to move the whole roller.

There are expanding front combs and back reeds for any number of ends, and Vee creels for any number of bobbins, with glass steps in the creels.

Each machine is fitted with a measuring motion, with indicator to show the number of yards wound, and also a knocking-off motion to stop the machine when the required yardage has been wound on each beam. Weights are provided for the beam arms to help in giving hard beams.

There are two drop rollers to take up slack yarn. Some devices are regarded as extras to be specified for by purchases as required and include the following :—

Expanding drums to expand up to 10 inches. Hardwood ends for drums. Brass rings on ends of drums. Clock face indicator

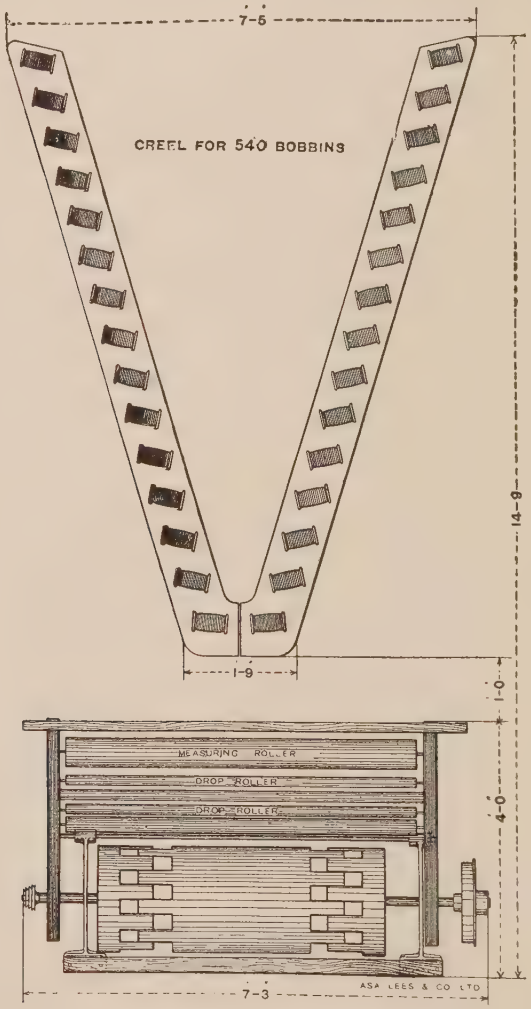

FIG. 34.

to indicate up to 50,000 yards in addition to measuring motion and indicator. Glass rods in creels.

Self-oiling bearings for drum shaft.

Conditioning arrangement with brass roller and water bottle with improved traverse motion. Tension roller for slack sides.

Lance-wood creel pegs.

Plan of 9/8*'s Machine with Creel for* 540 *Bobbins.* (Fig. 34).

These machines are made in the following sizes :—

9/8's to make beams up to 54″ wide.		10/4's to make beams up to 84″ wide.	
6/4's ,, ,, ,, 60″ ,,		11/4's ,, ,, ,, 90″ ,,	
7/4's ,, ,, ,, 66″ ,,		12/4's ,, ,, ,, 96″ ,,	
8/4's ,, ,, ,, 72″ ,,		13/4's ,, ,, ,, 102″ ,,	
9/4's ,, ,, ,, 78″ ,,		14/4's ,, ,, ,, 108″ ,,	

Usual size of driving pulley	15″ × 2″
Usual speed of driving pulley	45 to 50 r.p.m.
Power required per machine	about ⅓ i.h.p.
Approximate weight of 9/8's machine . . .	gross 22 cwt. net, 16 cwt.
Approximate measurement of 9/8's machine .	90 cubic feet.

It is possible to have an expanding zigzag front comb entirely mechanical in its action, and not dependent on springs for its expansion and contraction.

Ordinary Measuring Motion.—On the end of the measuring roller is a worm, driving a worm wheel of 54 teeth, which we will call M. On the stud carrying M is a second worm, driving a worm wheel, P, of 132 teeth. The worm only takes 1 tooth at each revolution, therefore a complete revolution of the first worm wheel represents a length of 27 yards having passed the measuring roller; this is equal to 1 tooth only on the second wheel, M; therefore a complete revolution of the latter means 3,564 yards—technically called a wrap $\frac{1}{2} \times \frac{54 \times 132}{1 \times 1} = 3{,}564$.

If a warp contains 4 wraps and 7 teeth, it is 14,445 yards long $= 4 \times 3{,}564$ added to 7×27.

Weight of a Beam or set of Beams.—Multiply the total ends by the length in yards, and divide by 840 and the counts.

Counts of Beams.—Divide the length by 840 and the weight.

Warping Cone Drive.

The cone drive was introduced many years ago in America and has had a limited number of applications in this country, and very many in America. It is intended to maintain uniformity of tension when winding the beam. It aims to either increase production by allowing extra speed or else make better and easier work by fewer yarn breakages.

The winding drum of the beam warper is driven through the

medium of a pair of cones, and a laterally moving cone belt after the manner so well known on bobbin and fly-frames.

The yarn unwinds from full warper's bobbins more easily than when the bobbins become smaller in diameter. Starting with full creel bobbins at a maximum winding speed 20 to 30 per cent. higher than normal, the speed may be gradually reduced to the normal before the time bobbins are ready for re-creeling, which latter operation may take up nearly one-third of the total working hours.

Inability to apply to existing machines has checked the cone drive application in England.

Beam Doffing Motion.

Warper's full beams are very heavy, say 250 to 300 lb. The large friction driving drum is fixed and constructed to facilitate doffing naturally, but special mechanisms to help in doffing have for many years been available if required. Overhead devices may be utilised for helping in both doffing and taking away the full beams.

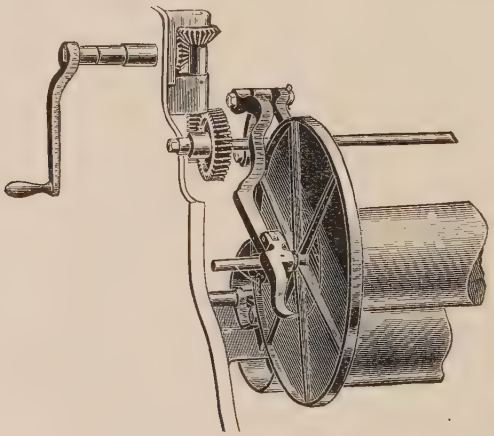

Fig. 35.

Fig. 35 shows a device made over twenty years ago by a well-known American firm. By its aid one person may readily deliver a full beam from machine to truck. A simple turning of the handle operates the gearing shown, and slowly lowers the full beam on the truck, being then ready to aid in replacing an empty beam.

Re-beaming Machine.

This is sometimes termed dry slashing, and the machine contains a headstock similar to that used for a slasher sizing machine, but there are no cylinders. Yarn beam friction.

Two roller yarn beam presser, double weighted. Ordinary marking motion, and expanding wraith. Inclined creel, six warper's beams with bearings vertically and horizontally adjustable.

This machine resembles the slasher sizing machine in that it assembles the ends or threads from several warper's beams into one single sheet or warp, and winds the same upon the weaver's beam. The cylinder sizing part is omitted, and the process suits certain cloths.

Ball-Warp Winding-on Machine.

By this machine, either ball or chain, dyed or bleached warps may be wound upon suitable weaver's beams.

The driving may be done by a pair of powerful friction plates, which are compressed for driving the beam by a convenient foot-lever extending the full width of machine, this foot lever being so arranged that it gives the operator full command over the driving, and enables him to promptly stop process if there be any entanglement of threads. As made by Howard & Bullough, a holding machine is supplied fitted up with two brake drums for the purpose of holding the threads at equal tension in passage to the machine.

Also an expanding front comb and a non-expanding reed with loose cap, specially adapted for laying-in the warp threads.

It is very seldom that re-beaming machines, ball warp winding-on machines, Yorkshire dressing machines, or slasher sizing machines form any part of the equipment of a spinning mill, the warper's product being usually the final product from the spinning side. Many mule spinning mills simply sell their yarns in the cop and include none of the machines subsequent to spinning.

Referring to Fig. 36, at R is the measuring roller, P, P′, the drop rollers working in vertical slides, *uu′*, S,T, guide rollers.

A wood drum for driving the yarn beam.

The stop-motion is not shown.

Hitchon's adjustable and self-stopping wrap indicator (see Fig. 37) is applied to many warping machines, and is made to indicate either yards or metres as required according to the circumference of the measuring roller ; and to give wraps of 3,500 and 5,000 yards or metres. It can be set to stop the machine at any required length.

Supposing a warp was required to be 5 full wraps plus 1,630 yards.

This wrap indicator can quickly be adjusted by lifting the

worm wheel out of gear, turning indicator until finger stands at 16 and pointer at 30, and then replace worm wheel.

The indicator will run backwards way. first running off the 1,630 yards, and then the 5 full wraps. The quadrant in this should be set with end of lever in that tooth of quadrant which is marked 6, giving one tooth for each wrap plus one tooth for the odd 1,630 yards, before the release takes place and the machine is stopped.

Assuming the warp is 3,500 yards there would be 3,500 × 5 + 1,630 = 19,130 yards length of warp, all wound before the auto-

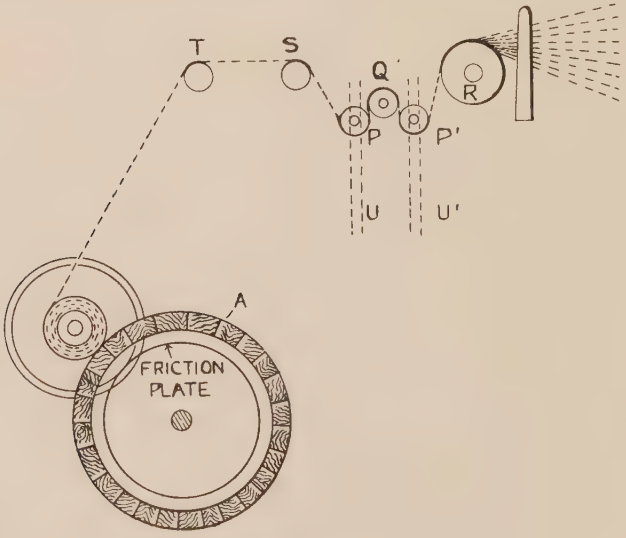

Fig. 36.

matic full length stop-motion operates. A model of this motion has long been in Bolton Technical School and is very interesting.

Heavy Warper's Beams.

Warper's beams are very heavy, possibly 500 lb.—but the front of a beam warper is admirably designed for dropping a full beam neatly upon a suitable truck or waggon.

In some cases hauling gear is applied to facilitate doffing and transit of full beams.

A handle and suitable gearing of a simple strong character are

utilised, and the beam may be moved up and down or backwards to the extent desired with a minimum of personal effort.

Cone Drums.—Cone drum driving is occasionally utilised for driving the friction drum of a beam warper.

In such cases the cone belt is slowly moved to smaller diameters of driving drum and larger diameters of driven cone, so that the

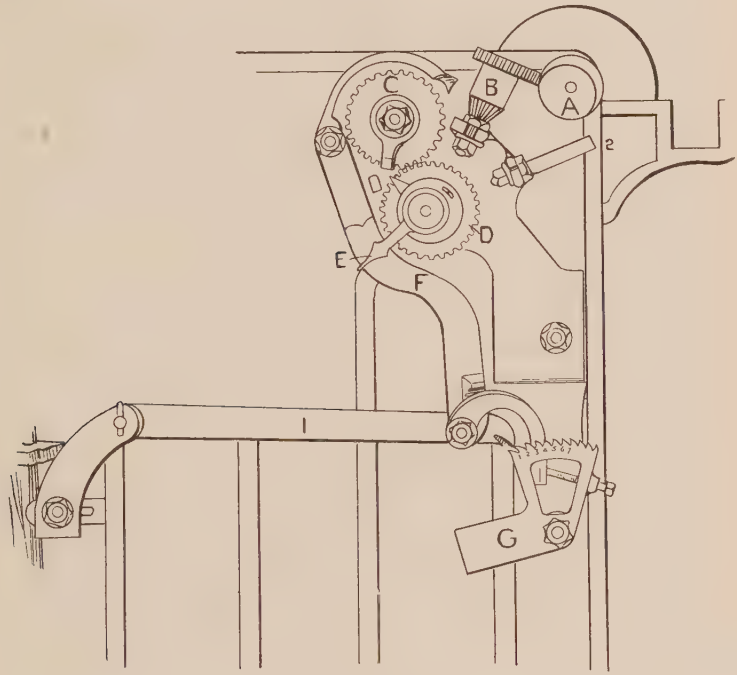

FIG. 37.

drum speed is diminished as the yarn beam increases in diameter and the creel bobbins diminish in diameter.

Warp removing devices and cone drums may be regarded as special features used or otherwise at the option of the mill officials.

The slack side preventer may be used to apply pressure to that portion of a beam which overhangs the outer edges of the drum. It may take the form of two conical rollers of convenient length and is optional in use.

Warp Run-Ways.

With the overhead run-ways to relieve the beamers, warehousemen, and labourers, special beam carriers travel on overhead run-ways in any desired direction and sustain the full beams all the time.

Such a beam railway may have ball bearings which make the running much lighter.

There is such a great trade now in selling yarn and delivering it on warper's beams that special attention has been given to improved and stronger beam flanges.

In some cases the wood beam has been bored through its full length and a metal tube inserted, continued in length beyond the flanges so as to form the pivots or beam bearings. Spinning mills making beam warps, the ability of small capitalists to start small weaving sheds in the room and power system, and buy warper's beams, have fostered transport of yarn in beam form in England.

Pirning from Ball Warps.

Ball warps are usually intended for preparing l ack beams or warps for the loom, mostly in yarns which have undergone some special treatment.

In some cases, however, it is the custom to make ball warps of weft yarn intended for the loom shuttle since ball or chain warps offer excellent facilities for dyeing in the bulk, obtaining uniformity in dyeing, and for transit purposes. A ball warp may be several thousands of yards long, and in one particular instance contains 378 ends. After bleaching and dyeing the warp may be taken to a pirning frame, suitably guided, tensioned, and opened out. A Rabbeth spindle is provided for each thread, the spindles are compactly arranged in bank form, guide wires pass along the faces of the spindles, a building motion is used after the style of a ring-frame, and cops or pirns formed on paper tubes. A compact, productive machine, and a method which gives uniformity in self-coloured goods, cheap to operate, and each warp thread making several cops on this special pirning system.

Section Warping.

Several firms make sectional warping machines. The object of a sectional warper is to wind the yarn from warper's bobbins on to section blocks varying from about 3½ to 11 inches wide. The bobbins are placed in the usual manner in either a Vee-shaped or crescent shaped creel. The threads are taken through much the same intermediate parts as in beam warping—including a self-stopping

mechanical or electric stop-motion. Finally to the section headstock to be wound on the section block. The measuring roller may be made for either yards or metres. There is usually a positive pressing motion, automatic regulator for obtaining uniformity in length and diameter of sections. Vee wraith and lease reed, expanding front comb and back reed; Vee creel for 504 bobbins, bushed possibly with box-wood steps; glass rod to each upright stave, and drop pins as required. (The self-stopping part of the machine may be known as 9/8 wide, and 68½ inches between framing. If a creel for 600 bobbins be ordered then the framing at the self-stopping part may be wider than just stated.)

Winding-off Machines.

For uniting and transferring several sections made on the sectional warper on to the weaver's beam, a winding-off frame may be used. The machine is provided with a steel bar having binding flanges and tightening arrangement for carrying the cheeses or sections; also with headstock and driving gear for driving the yarn beam. Weaver's beam stands made suitable for either wood or iron beams, with adjustable bracket to suit various lengths of weaver's beams. The machine is of somewhat strong construction. There are also convenient machines for winding ball warps upon weaver's beams. Such a machine may be provided with cast-iron warp dish for carrying the ball warp, turned and polished nip and drag rollers, with levers and weights for same to give the requisite tension to the warp. The headstock may be fitted with strong leather-covered friction rollers made to expand to suit various widths of beams; levers and weights for pressing the weaver's beams; stand expanding wraith and vibrating motion for same.

Instead of using the section warping machine, when a weaver's warp is required of various or mixed colours, several small warps may be made on the warping mill, dyed in required colour, then dressed on to the weaver's beam on the Yorkshire dressing frame. It is, of course, possible as an alternative method to dye the yarn in hank form and transfer to winder's bobbins ready for the mill warper.

The sectional warper is a more modern method than the mill warper and has received a good deal of adoption, as it is supposed to save time, trouble, and expense in the preparation of coloured warps.

The creel, drop-wire motion, and stop-motion, much resemble those for beam warping, but the headstock differs considerably, and is perhaps the most complicated headstock and gearing of any warping machine.

A wood block of possibly 6 inches width and 8 inches diameter

is used to wind the yarn upon, and is driven round by a friction pulley arrangement so as to give slower speed as diameter of section increases. Narrow beams of any different or mixed colours are easily made, and are afterwards united into one weaver's beam in any order and to any width desired. Width of cheese may be from about $3\frac{1}{2}$ to 11 inches.

The outside sections may need special yarns for the selvedges of weaver's beam.

For example a section warp may need 30 ends blue, 4 red, 10 white, 10 red, 10 white, 4 red, or 68 threads in three colours for one pattern; and there might be 6 repeats of these = 408 in the section + a certain number of selvedge ends when the selvedge sections are made.

A measuring motion to record and regulate length of warp on each section of a series is a part of the mechanism. Each flangeless section or cheese is removed as finished, and a second wood block used for the next section. The final weaver's beam from the section winding-off machine might contain five of above sections + selvedge ends. A special bar and tightening arrangement for the sections is needed in the creel of the winding-off machine. After having the reed and healds attached the weaver's beam is ready for the loom. When yarn in one section differs in thickness or counts from the yarn in another section arrangements are provided for making all the sections equal in diameter for the same length, possibly 700 or 800 yards in length.

As the presser moves away from beam centre, owing to increasing diameter of cheese, the driving bowls for the section roller are moved nearer to the edges of the motion flanges, having the effect of giving a slower rate of revolution to the sections, in order to reduce the revolutions, but keep the winding-on speed about equal for all diameters of cheese. This friction driving is maintained by springs or weights. The yarn may pass over a measuring roller of 18 inches circumference, which drives the measuring motion, and possibly also the stopping motion.

The lease reed may have alternate threads passing through alternate dents, and when it is required to take a lease at the end of each section, the machine is stopped and the reed lowered to bring down all the threads in the odd numbers and the even numbers in the top shed so that the leasing string may be inserted.

The reed may be reversed to give the other shed, and a second string inserted, so that the threads are now one under and one over the lease string.

The sections are in cheese form with self-supporting edges, pressure being applied to help in good hard cheeses with good selvedges.

When changes are made in width of section, counts of yarn

and number of threads, ready means are provided for re-setting the presser and speed motion.

In some instances sectional warping bobbins or tubes have been fitted with thin flanges to obviate the possibility of some threads falling off the cheese edges and then becoming locked when several cheeses are put together at the section winding-off machine. A strip of felt or cloth nailed round the edge or a few threads of thrums tied round the section edges, may help to prevent threads falling off the edges of the sections.

In process of section reeling the threads may be fastened in hole of section block and machine slightly turned for half a revolution of section. Now put in the lease; then turn machine another half-revolution of cheese. The measuring motion may now be set to give correct knocking-off and length of cheese.

The Yorkshire dressing frame is in extensive use for transferring ball warps of different colours, in proper sequence to weaver's beams so as to form warp stripes of coloured yarn. The threads are passed under and over tension rods, extended a good distance, well brushed and spread out, assembled as required, and finally wound upon the weaver's beam.

Holroyd's Winding Frame.—A common system in the production of section warps of coloured yarn is the following:—

A. (1) Reeling the yarn into hanks, (2) bundling for transit, (3) bleaching and dyeing, (4) re-winding upon warper's bobbins on the drum or other winder, (5) place these bobbins in section warper creel, (6) wind off the sections upon weaver's beam.

B. By using Holroyd's or similar winding frames the following may be the system:—

(1) Wind the yarn upon flanged bobbins, (2) make ball warps on the mill warper, (3) bleach and dye, (4) re-wind on Holroyd's from dyed ball warps upon warper's bobbins, (5) section warping, (6) use the section winding-off machine to make the weaver's warps.

The chief advantage claimed for this second system is that the ball warp allows of the whole of the warp being dyed in bulk, in longer lengths than reeled hanks, and this reduces cost and perhaps guarantees uniformity in colour better.

Equal Diameter of Sections.

A chief problem in section warping has always been that of obtaining cheeses of equal length and equal diameter so that they will run off equally at the winding-off machine.

Bethell's arrangement has done well in this item. The presser is made to recede from beam centre at a determined rate of progression and in a more or less positive manner, so that if two sets

of threads of somewhat different diameter were combining to make a warp, the thinner threads would not only be reeded closer together but would receive a less amount of pressure, and would more easily expand to the diameter of the thicker and more heavily pressed thread section.

In making what might be termed a trial section the presser mechanism may be disconnected, the number of section shaft revolutions accurately noted; the mechanism may then be set to make all the sections of equal length, while the positive presser helps to give uniformity in diameter.

In some frames there is a worm and worm wheel indicator arrangement operated from the end of the section shaft in order to accurately record the length of warp.

This indicator is additional to the clock face indicator which registers up to 50 or 100 yards by a quickly moving finger, and longer lengths by a second and more slowly turning finger.

Section warper, beam warper, mill warper, chain warper and cross-ball warper, are the various types described. Some practical men consider that section warping has scarcely obtained the success it promised to have about 1892.

Slack Sides Preventer for Warps.

In making warps there is sometimes trouble with the sides or selvedges. It is of primary importance that uniformly wound beams should be produced, having all the threads of equal length and warped at the same tension. Of recent years it has become more and more recognised that quality and quantity in weaving at the loom depend a great deal on quality of the yarn and back beams for the weaver's warp, as well as on the weft cops.

What are known as slack sides on the beams have often been exceedingly troublesome to the weavers, and may be due to such causes as :—

Crooked beam flanges, uneven beam sides, faulty setting of expanding drums.

Such things may cause the threads nearest the beam flanges to build up more rapidly than the rest of the beam due to want of pressure in the angle formed by the flanges.

Blackhurst's "slack sides preventer" has received extensive adoption and is a very simple device. A light pressure is placed on the warp sides by a pair of wooden conical rollers mounted to revolve in close contact with the warp sides or beam flanges. In this way the warp threads nearest the flanges are prevented from building up to a larger diameter than the rest of the beam.

Tying-in and Twisting-in.

In the case of many woven cloths especially such as Burnley or Glossop printers, looms may go on weaving exactly the same sorts of cloth for many years, no reed or heald alterations taking place, and the same ends per inch of width, but subject to alterations in picks per inch and in quality of yarn used.

In such cases twisting-in is very common, the object being simply to piece the leading ends of the new beam to the final ends of the old beam.

A great deal of hand twisting-in is still done, although automatic warp tying and drawing-in machines have been in use for several years.

For hand twisting-in the operator—man or woman—has the healds on the left hand, and the new full beam on the right, the only apparatus being stands to carry the material and beams. A good warp tying-in machine, with a competent operator and assistant, could tie well over the rate of a quarter of a million of ends, 30's/34's American twist in a forty-eight hour week.

Faults in Beam Warps.

Beam warping at the spinning mills has greatly increased during recent years, largely due to ring spinning mills often selling their twist yarns in beam form, although mule twist is also made into beam warps when required.

Defective, empty beams having splintered or rough barrels, twisted or uneven flanges, wrong distances between flanges, became rather frequent during the high prices of accessories in the early post-war days.

Mixed sorts of yarns at the beam-warping can scarcely be excused, and may cause trouble in later processes—especially in warp dyeing, by having different tensions among the threads. More or less common yarn faults, such as short twist due to slack strings, snarls, and bad ends, are sure to give trouble in sizing or in dyeing. Snarls lead to uneven dyeing, and places showing up a poor tint. Over-conditioning of warp yarn, and the warps then stored in a warm place, may cause mildew.

Beam warps are sometimes sent away with very poor wrapperings, carelessly applied, and there is often more or less damage in transport. Probably direct delivery by motor minimises this trouble, as against the double loading and unloading of railway transport.

In motor transport it is reprehensible to carry empty beams loaded against full beams, so that flanges cut the yarn. All carters and others who handle the warps in transit should be very careful of damage to the yarn, and good wrapperings help in this direction.

In warp dyeing the dyers themselves are often to blame for warp damage by storing warps against damp walls, by careless handling before treatment, by having guide rods and pegs out of order, boxes and wagons wanting repairing.

Notes.

Ball and beam warps are now very often made at the spinning mill, although most yarn is still sent away in cop form in England.

Drawing-in and tying-in for weaver's beams really belong almost exclusively to weaving concerns.

In an automatic warp tying-in machine the new and old warp ends are firmly clamped in oppositely placed sheets, parallel.

The machine has parts which pick up the corresponding threads from new and old warps, ties these together by knots of uniform size and loose ends automatically cut off.

From the writer's personal observation such machines must be competently attended to in every way because they need to be instruments of precision. It is really wonderful to watch the working of such a machine in good order, well handled.

The Northrop Loom.

A good deal of weft yarn is now spun directly upon wood ribbed pirns of small diameter at the ring-frame. Such bobbins may go directly to the loom shuttle. The Northrop loom is fitted with an automatic stop-motion for broken warp threads.

Its most distinctive feature, however, consists in the use of a magazine or revolving circular frame for holding cops or such small weft pirns as above alluded to.

Most ingenious mechanism is used by which a practically empty cop or pirn is automatically displaced by a full one and all connected operations quickly and efficiently made.

Such a magazine may hold up to 25 cops or wood pirns.

Yarn Passage from Spinning Machine to Loom.

The procedure varies according to destination and cloth requirements.

Grey weft may proceed direct from mule to loom, with or without conditioning between.

Coloured weft must be handled in some form, such as reeling and bundling, for dyeing purposes and then afterwards rewound.

Twisting-in, drawing-in or tying-in of new to old weaver's beams is always necessary.

1. Grey warp yarn more usually has just three intermediate processes between spinning machine and loom, viz. upright spindle

winding, beam warping, slasher sizing, in which also several warper's beams, often 4 to 6, are assembled and condensed into one weaver's beam. There is also either twisting-in or else drawing-in.

2. For grey goods it may occasionally happen that ball warping displaces beam warping, but the latter is much simpler, much more used, and only requires women warpers. If it should happen that for some reason the ball warper is used, then after winding as in (*a*) the large ball or mill warping machine is used for ball or chain warping, and is followed by ball sizing and then beaming or winding upon the loom beam.

For coloured goods one of several methods may be adopted.

3. Winding as before. Warping as No. 2. Bleaching, dyeing, and sizing in warp form. Yorkshire dressing, and in same large frame, slowly winding the dressed yarn upon the weaver's beam.

4. Instead of bleaching and dyeing in the form of a ball or chain warp it is often preferred to do such work with the yarn in hank form.

(*a*) Use a cop or bobbin reel and put the yarn into cross-reeled hanks.

(*b*) The treatment for bleaching, dyeing, sizing as required.

(*c*) Wind the yarn from the hank form upon flanged warper's bobbins using the latch and catch slow traverse drum winder, or the upright spindle winder. Either the ball warper or the sectional warper may now be used, followed by the necessary winding and assembling of the threads upon the weaver's beam.

It is possible to use the beam warper even for coloured goods, but scarcely so convenient for yarn mixtures as the other methods.

Beaming.

In one sense the transfer of beam warping from the weaving to the spinning mill, largely due to the extended adoption of ring-spinning for warp yarns upon comparatively large spools or bobbins not convenient for transport, has not been a benefit to the slasher sizer or to the weaver.

With the beam warping, under the same manager, in the same building as the slasher sizing, and very near thereto, the beam warpers are obliged to be very careful in their work.

While the beam warping is done very efficiently in the making-up departments of some spinning mills, there are other cases in which it does not appear to be realised that good carefully made warpers' beams go a long way towards helping the work of the slasher and the weaver, when the beams reach the weaving concern. Good beam warping makes sizing and weaving easier and adds to the quantity and quality of cloth produced. The flanges of the beam warps should be kept in good condition, of exact distance apart.

CHAPTER IV.

FLYER DOUBLING.

The flyer system of twisting, guiding, and winding textile rovings, single yarns, and doubled yarns, has proved its usefulness from the time of the Saxony wheel, some centuries ago, down to the present day.

In doubling it proves its adapability on the one extreme for fine two-fold threads, and is unequalled on the other hand for very heavy thick productions of many doublings, and low twist per inch.

The flyer doubler, perhaps, more usually has only one tin roller, but is often also made with two.

Twist Way v. *Weft Way.*

To change from twist way to weft way the spindle bands may be reversed as on other spinning or doubling machines, but the screwed spindle top for holding the flyer is sometimes an obstacle in such reversing from twist to weft. Later in this chapter is shown a method of reversing spindles without touching the spindle bands.

It is possible to have spindle tops threaded both twist way and weft way to meet possible reversals of spindle direction. Otherwise it might be necessary to change all the spindles and flyers opposite screwing to avoid flyers being thrown off in twisting.

In a double screwed spindle the left-hand thread would be of smaller diameter than the right-hand thread, which is lower than the other one. Two sets of flyers would be used, but the flyers are smaller and less expensive than for a roving frame.

The curl or thread eye of the flyer may be either inside or outside of the flyer, but the inside curl permits a closer spindle gauge. Both curls are much in use.

The flyer has an advantage in long lifts since the flyer eye serves equally at all points of the lift. In ring doubling a 5-inch lift will put more yarn on each bobbin than a 4-inch lift, but gives varying degrees of tension on the threads.

Winding Principle.

On the ring doubler winding-on is accomplished by the traveller losing revolutions as compared with the bobbin and spindle. The traveller is pulled round by the thread, and any easing of the thread pull by reason of roller delivery, permits the traveller to go slower and help in the winding-on, as well as in the guidance of the thread. Heavier travellers give harder bobbins. Bobbin fast to spindle whereas in the ordinary flyer doubler the bobbin is loose on the spindle and is drawn round by the pull of the thread. There are some who claim that the passage of the thread round the flyer leg helps to consolidate the thread, lay any loose fibres, and do a little polishing of the yarn.

Also that the twist per inch is very regular and the doubled thread has a wiry, solid, glossy, uniform appearance as the result.

Fly throstle winding-on is done by the bobbin losing revolutions on the spindle, in proportion to rate of thread delivery, and diameter of bobbin.

Use of Flyer Doubler.

"Extremes meet" in the fact that the flyer doubler retains its position and is favoured for certain classes of fine yarns on the one hand—such as for lace two-folds, and for heavy doublings on the other extreme, such as for tyre yarns, nettings, twine and sail cloth yarns. Between the extremes of coarse heavy work and fine two-folds, the flyer is not much used in the cotton trade.

Details of Machine.

Flyer doublers differ very little in the gearing, creeling, and expression or conducting rollers, from ring doublers, but differ materially in the spindle, bobbin, twisting, and winding-on arrangements.

They may be adapted either for wet or dry doubling, but the English system is used for wet work. Either double or single tin rollers. Twist per inch changes as on ring doublers, and lifter driving or copping motion much the same.

Lubrication.—Lubrication of the spindles of flyer doublers may be done at doffing time.

The spindles may be greased by hard waste or a bit of clean cloth dipped in suitable oil—say sperm oil, for example, or else special thin grease. There may be trouble with the bobbins causing the oil to fly on the yarn when the oil is thinned by heat and friction.

When required, between long doffing times, each revolving

spindle may be just touched by an oiling stick, when the traverse is at the top.

A foot long piece of wood covered with flannel at the end may be used as an oiling stick.

Flyer Polishing.—After repairing, flyers may need polishing. The polisher may be simply a revolving barrel containing cheap and suitable bits of cleaning material, such as bits of roller leather and cardboard placed in the barrel with the flyers. In action the polisher may be less than one-fourth full to give space for the jigging effect. This polishing of flyers may be done at any time when flyers get sufficiently dirty, rusty, or covered with durable fluff. A polishing mill may be about 3 feet long and 2 feet diameter and make possibly 36 r.p.m.

Set Tickets.—Sets of bobbins in doubling require ticketing almost more so than in actual spinning. The set ticket may indicate final purpose of the yarn, twist per inch, quality, counts, folds, date and number of side or of frame.

In weighing-in of sets it is not only necessary to know the weights of empty tins or baskets, but also the weights of the empty bobbins in use. In some cases there is also noted the possible effects of twist shrinkage, and conditioning at the doubler, or at a later stage.

As in roving frames, stained yarn may be due in flyer doubling, to the use of old bobbins saturated with oil.

The loss is greatest in the case of fine, expensive yarns.

Points to observe are as follows:—

1. Use of flanged bobbins and of cheeses in the creels.
2. Wet doubling in one and dry in the other.
3. Double tin rollers and single tin rollers.
4. Spindle band drive and tape drive.
5. The gearing plan or method of driving rollers.
6. The copping or lifting motion.
7. Methods of guiding the yarn round the expression rollers.

Tape Driven Spindles for Spinning or Twisting Frames.

In Yorkshire many twisting spindles have been effectively driven by flat tapes instead of round spindle banding, the tape system probably appearing to the best advantage for doubling spindles, or any heavy spindles.

A good deal of tape driving for ring-frames exists in America. We can have tape driving applied to a flyer doubler.

By using a carrier or jockey pulley along with a single tin roller, one tape may be conveniently made to drive two spindles on each side of a ring spinning or ring-doubling frame.

Tape driving has been well tested on ring-frames without using

a tension or jockey pulley—one tape driving a spindle on each side of the frame.

It is claimed that tape driving gives: a wider contact of band and pulley, reduced power consumption, more regular twist. The use of tension or jockey pulleys complicates threading of the spindle bands and has hitherto been a great set back to the use of tape, although lighter materials are now again bringing the matter forward.

Tape piecings may be made by overlapping the ends about 3 inches and stitching by the aid of a portable sewing machine. Other methods have been tried but this one apparently is the favourite.

Recent tension pulley arrangements may permit ready changing from twist way to weft-way, having both sides the same way, or one side weft-way, while the other side is twist-way.

Bolsters, Flyer Curls, Tin Rollers.

(*a*) A travelling bolster rail may be used on plain flyer spindles; but for 5 inch or 6 inch lift for heavy cords, a stationary bolster rail may be used, with an extra lifting rail to carry the bobbins.

(*b*) The inside curl of flyer eye permits larger bobbin flanges without increasing the spindle gauge, and is therefore often favoured.

Some users prefer the outside curl because it offers more frictional surface to the yarn, and is considered better for the life of the flyer eyes.

(*c*) Except for high speeds of spindle 8-inch diameter of single tin roller is deemed a usual maximum, to prevent extreme angles of bands. Sometimes for high spindle speeds, single tin roller of 9-inch diameter is used. The double tin roller system always keeps a correct angle of spindle band in both spinning and doubling.

(*d*) The most common system is to have the expression rollers to turn inwardly at the delivery point, but outward delivery and glass vertical fingers are preferred for some two-folds.

Speeds and Gauges.

Flyer doublers are usually on the English system for wet doubling, and are scarcely ever used by the Scotch makers of sewing thread.

Frames 300 spindles long, $2\frac{3}{4}$-inch gauge, 8-inch single tin rollers, $1\frac{1}{8}$-inch or $1\frac{1}{4}$-inch spindle wharve, mill shaft making 300 to 350 r.p.m., containing a 28 inch or 30 inch drum driving down to a 12-inch frame pulley.

Heavy doublers may be made with chain and bowl arrangement for lifting motion, with heart cam and levers for straight lift two-headed bobbins, one side of rails to balance the other side.

3½	inch	gauge,	3½	inch	lift,	3500	spindle	speed	=	55	spindles	per i.h.p.
4½	,,	,,	4½	,,	,,	2800	,,	,,	=	40	,,	,, ,,
5	,,	,,	5	,,	,,	2300	,,	,,	=	35	,,	,, ,,
6	,,	,,	6	,,	,,	1800	,,	,,	=	25	,,	,, ,,

Tension Scale.

A band tension scale may be used if required, for testing the tension of spindle bands, but practical experience and individual judgment are more often relied upon.

In Fig. 38, A takes the place of the spindle wharve, C the handle; at B is the scale to register the tension applied to the spring by the spindle band.

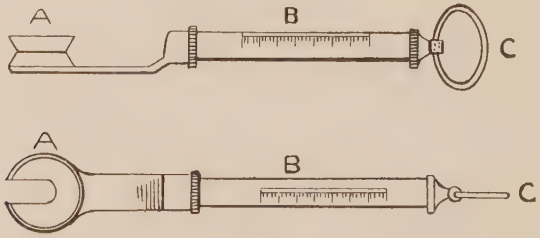

FIG. 38.

Roller Stop-Motion.

Fig. 39 represents a long-established individual thread stop-motion for those who require such a thing.

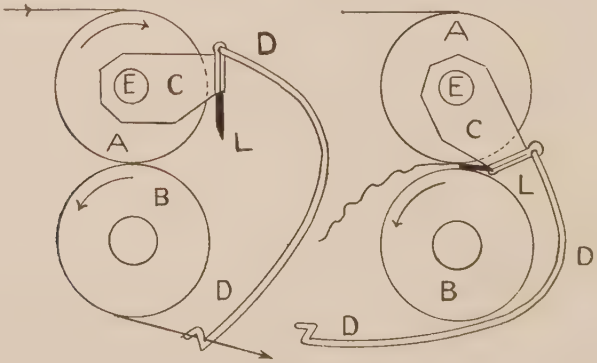

FIG. 39.

At the left hand, the thread is shown holding up the wire D and keeping the leather tongue, L, away from the expression rollers, A, B.

The arrangement swivels loosely on the end of each top roller E.

On the right hand failure of the thread has allowed drop wire D, to fall and leather tongue, L, to pass between rollers A, B, so as to lift up the top roller, A, to prevent this roller from drawing off more creel thread and causing roller laps.

Sharkie's four-fold preventer is of more recent introduction and on an extended principle as explained later on.

Constants, Twists, and Productions of Flyer Doubling Frame.

(Messrs. Brooks & Doxey of Manchester.)

The twist per inch in doubled yarn varies so much for the same counts and fold that the following productions should only be taken as the basis for what can be obtained, as much also depends on the help given at doffing on coarse counts (see opposite page). For forty-eight hours or for any other period a proportion could easily be established.

Flyer Doublers.

The spindles usually run weft way, that is, the contra direction to which the yarn is spun. It is very necessary to fix this as upon it depends the thread for screwing flyer on spindle, and so that correct thread wire can be used. If double thread and 2 sets of flyers are ordered so as to make both right and left hand twist, it should be stated which thread is to be used the most, so as to put that thread first on the spindle.

The twist per inch varies according to the purpose for which the yarn is used, and no definite rule can be given, for it is usually made to match a sample, but the following may be taken as a rough guide :—

60's/2	to 100/2	super crape quality	$\sqrt{}$number ×	$6\frac{1}{2}$.
60's/2	,,	for manufacturing	,, ×	5.
60's/2	,,	preparing sewing	,, ×	5.
60's/6	,,	finishing ,,	,, ×	7.
36's/3	,,	preparing heald yarn	,, ×	5.
36's/9	,,	finishing ,, ,,	,, ×	8.
32's/5	,,	preparing fish nets	,, ×	5.
32's/25	,,	finishing ,, ,,	,, ×	10.

Example : 50's/2 = 25. $\sqrt{25} \times 5 = 25$ turns.

In every case the range of twist per inch must be fixed and

also twist per inch on which the machine will be started so that the gearing and twist wheels to suit may be arranged.

USE.	Counts and Fold.	Spindle Speed.	Gauge.	Lift.	Diameter of Bobbin Head.	Constant for Twist $\sqrt{\text{counts}} \times$	Twist per Inch.	Inches per Minute.	Hanks per $56\frac{1}{2}$ Hours.
			Inch.	Inch.	Inch.				
Crape and bobbin net yarn	100/2	5000	$2\frac{1}{4}/2\frac{1}{2}$	2	$1\frac{5}{8}$	5	35	142	12·9
	140/2	5000	$2\frac{1}{4}/2\frac{1}{2}$	2	$1\frac{5}{8}$	5	41	122	11·1
	200/2	5000	$2\frac{1}{4}/2\frac{1}{2}$	2	$1\frac{5}{8}$	5	50	100	9·0
Crape yarn . .	50/2	4500	$2\frac{3}{4}$	$2\frac{1}{4}$	$1\frac{3}{4}$	$6\frac{1}{2}$	32	140	12·7
	80/2	4500	$2\frac{3}{4}$	$2\frac{1}{4}$	$1\frac{3}{4}$	$6\frac{1}{2}$	41	110	10
	100/2	4500	$2\frac{3}{4}$	$2\frac{1}{4}$	$1\frac{3}{4}$	$6\frac{1}{2}$	46	98	9
	40/2	4200	$2\frac{3}{4}$	$2\frac{1}{2}$	$1\frac{3}{4}$	5	22	191	17·3
	50/2	4200	$2\frac{3}{4}$	$2\frac{1}{2}$	$1\frac{3}{4}$	5	25	168	15·2
	60/2	4200	$2\frac{3}{4}$	$2\frac{1}{2}$	$1\frac{3}{4}$	5	27	155	14·1
Preparing for heald yarns	30/3	3800	3	3	2	5	16	238	21·6
	50/3	3800	3	3	2	5	20	190	17·2
	100/3	3800	3	3	2	5	29	131	11·9
	150/3	3800	3	3	2	5	35	108	9·8
Finishing heald yarns	30/9	3500	$3\frac{1}{2}$	$3\frac{1}{2}$	$2\frac{7}{16}$	8	14	250	22·7
	50/9	3500	$3\frac{1}{2}$	$3\frac{1}{2}$	$2\frac{7}{16}$	8	19	184	16·7
	100/9	3500	$3\frac{1}{2}$	$3\frac{1}{2}$	$2\frac{7}{16}$	8	26	134	12·1
	150/9	3500	$3\frac{1}{2}$	$3\frac{1}{2}$	$2\frac{7}{16}$	8	32	109	9·9
Preparing for fish nets	20/5	3500	$3\frac{1}{2}$	$3\frac{1}{2}$	$2\frac{7}{16}$	5	10	350	31·8
	30/5	3500	$3\frac{1}{2}$	$3\frac{1}{2}$	$2\frac{7}{16}$	5	12	292	26·5
Finishing coarse sewings and heald yarns	20/9	3200	4	4	$2\frac{3}{4}$	8	12	266	24·2
	30/15	3200	4	4	$2\frac{3}{4}$	8	11	290	26·3
	16/6	3200	4	4	$2\frac{3}{4}$	8	13	246	22·3
	20/6	3200	4	4	$2\frac{3}{4}$	8	14	228	20·7
Finishing fish nets and cords	20/15	2800	$4\frac{1}{2}$	$4\frac{1}{2}$ or 5	$3\frac{1}{4}$	10	11	255	23·2
	30/15	2800	$4\frac{1}{2}$	$4\frac{1}{2}$ or 5	$3\frac{1}{4}$	10	14	200	18·1
Finishing fish nets and cords	24/18	2300	5	5	$3\frac{3}{8}$	10	11	209	19
	32/18	2300	5	5	$3\frac{3}{8}$	10	13	177	16·1
	36/30	1800	5	6	$3\frac{3}{8}$	10	11	163	14·8
	60/30	1800	5	6	$3\frac{3}{8}$	10	14	128	11·6
Finishing cords .	10/21	1800	6	6	$4\frac{3}{16}$	8	5·5	327	29·7
	36/16	1800	6	6	$4\frac{3}{16}$	8	12	150	13·6

Beam Doubling.

A modern development in cotton doubling consists in doubling from the beam, and tyre yarns have provided a use for this method and revived the use of flyer doubling.

The threads on a beam warp are exceedingly long, and careful winders and warpers will keep the knots and piecings of one cop yarn to another unobtrusive and not over long, especially if aided by a good mechanical knotter.

Several excellent firms make flyer doubling frames with back beams if desired, and among others we have Messrs. Asa Lees & Co.

As the threads unwind from the warper's beam several of the threads may be put together and twisted into one strong thread in one operation, the long warp threads—possibly 20,000 yards giving the minimum of stoppage for any thread purposes. For these heavy doublings the flyer doubler is best and gives a very uniform product. An ordinary warper's beam may contain up to 500 threads, but for this beam-doubling frame about half this number is more likely.

The flyer arrangements differ from those of a roving frame to suit the heavy nature of the work; positively driven, ordinary top slot fastening of flyer to help doffing, and to permit either twist way or weft way.

The thick produced cord requires good sized bobbins say 6-inch lift × 4½-inch full diameter, special arrangements for the application of a stout adjustable drag cord.

Bobbins drawn round by the threads, and winding accomplished by retardation of bobbins by the drag cord, and their own weight.

One beam of 288 ends may supply 24 flyer twisting spindles if it be twelve-fold. Cabling is sometimes resorted to as, for example, 5 cord × 3.

Special Flyer Doubling Frame.

In order to obtain the perfectly uniform twist which is so essential for such yarns as tyre yarns, etc., the spindles in this special type of doubling frame are positively driven by bevel gearing.

The machine illustrated is made to double yarn from warpers' beams so that very long lengths can be doubled without any knots, but machines of this type can, of course, be made with creels for bobbins or cheeses if desired.

Spindle Reversing Motion.

Doubled yarns are sometimes required with the twist put in "twist way" and sometimes with the twist put in "weft way." The usual method of reversing the direction of the spindles to obtain this variation is to reverse the belt driving the machine, and thus reverse the direction of the whole machine. It is then necessary to alter the delivery rollers back again to the original direction. These alterations necessitate a stoppage of the machine for a considerable time, and there is patent gearing designed to

simplify the alteration in the direction of the spindles and to save time.

A wheel on the driving shaft drives the spindles "weft way" through two carrier wheels. When it is desired to change to "twist way," all that is necessary is to move this wheel along the shaft out of gear with the small carrier wheel and into gear with the large single carrier wheel, with the result that the spindles are driven in the opposite direction.

The Motor Industry has given a tremendous impetus to the amount of doubled yarn required in the world.

Cabled tyre yarns of great smoothness and strength are produced by using single yarns of 23's counts, 15-fold, first made in 5 cords and then 3 × 5 in the cabling or second doubling.

First doubling the spinning way and second in the reverse direction.

This heavy cabled yarn may be woven into a loose fabric with perhaps four picks per inch of weft, the required cloth strength being obtained from the strong cabled warp, while the weft holds the warp threads in definite order. There are other methods.

The procedure may involve: (*a*) the spinning of the single yarns —ring yarn often required—(*b*) winding five ends together, (*c*) ring twisting in five cord, (*d*) second winding in which we put together three of the five cords, and finally (*e*) flyer twisting.

As before described in this chapter there are now many warp doubling machines in which all the threads for one spindle or doubled thread are assembled together in the one machine.

Inverted Flyers.

About 1880 a Bolton firm of doublers applied an inverted flyer to some of their doublers, but one cannot hear of its ever receiving extended adoption.

One of the troubles of ordinary flyer doubling in fine numbers has been the need for oiling the spindles at doffing time in order to get proper winding without thread breakage. Frequently bobbins have got saturated with oil and become much heavier for the thread to pull round.

Cleaner bobbins pull round differently and variation in drag is obtained. Oil saturated bobbins on both flyer doublers and roving frames will sometimes stain the cotton product.

In the device mentioned, the flyer was removed from the spindle top, turned upside down and placed in the position of the bobbin, which could be put on or off the spindle much after the method on upright spindle winding frames. The bobbin was held sufficiently firmly by the spindle, and pulled the flyer round to give twist, tension, and wind.

Beam Doubling.—Creels in centre on top often each one serving for 24 spindles, so that a frame of 144 spindles would take 6 beam warps, 23's/11 to 23's/13-fold, or 23's/15-fold.

This trade at the moment for tyre yarns appears to be giving way to the more ordinary type of doubler in which 5 ends are wound and twisted together, and then cabled 5 × 3 into 23's/15.

System A, or 2 bobbins of 6-cord, allows a creel bobbin to become soon empty. System B, or 6 bobbins of two-folds keeps creels going longer, but is more liable in 6 × 2 to have one end broken and give a form of "single."

Tape Banding for Doubler Spindles.

An old idea as per Dr. Ure, 1836, but lately gaining greatly in favour. Each tape threaded and then sewn piecing say $\frac{7}{8}$-inch tape for 1-inch spindle wharve.

A frame in Bolton on this basis only had one band to renew in four months. Four spindles for one tape, with specially wide wharves.

One jockey pulley 7 inches diameter for each band.

One objection has been great trouble in re-setting jockey pulleys when spindle bands are reversed. This may now be done from frame end all at one time quite readily.

Lace Trade Depression.—Many lace-yarn makers delivering yarn only in hank or bundle form have just now widened their opportunities of trade by adding making-up machines to suit other markets, so they may deliver yarn either in warp form, cheese, cone or hank as required.

Casement curtains instead of lace, sponge cloth dress pieces instead of voiles or crepe-de-chene, greatly affect some producers of yarn and cloth at the time of writing.

Flanged Bobbins.

To prevent winding thick edges on flanged warpers' bobbins it is possible to apply a traverse just slightly shorter than full width, and to apply mechanism which automatically moves the traverse $\frac{1}{8}$ to $\frac{1}{4}$ inch or so in its width in relation to the bobbin.

Ring Spinning Frame for Doubling.

Without being at all ideal in lift, gauge, diameter of ring or other factors, it is quite possible to convert a ring spinning frame to become a doubler.

Because a fancy doubler often requires two pairs of rollers to give different rates of delivery, and direct or indirect threading of the component yarns, the middle rollers of the ring spinner—

either in top middle only, or in both top and bottom—may be removed for the purposes of fancy doubling.

For plain, dry doubling, the front pair may be used. This remark has been made owing to many people asking if a gimp yarn could be made on a spinning machine.

Gimp and truffle are names given to a certain fancy yarn used in the new sponge cloths, and the sponge cloth is often called rateen.

Dr. Ure (1836) shows a flyer doubler gearing very much on same lines as now made.

An Egyptian view shows textile doubling to be of great antiquity.

Twiner Yarn is cleaner because of no ring grease and long lengths. It is fuller because of spinning in long lengths and throwing out of fibre. Cone creel bobbins in twiner enabled the piecers in war time to go on mules, and women winders do the cone winding.

Modern Waste Preventer for Doubling Frames.

The increase in efficiency of manufacturing processes is a waste-preventing tendency.

The four-fold and roller lap preventer explained herein is very simple, and offers little difficulty to the operator. It is not easily put out of action (and if it is put out of work, its non-action is at once noticeable).

It is not liable to get clogged by the action of water or slime which may accumulate.

It has also the distinct advantage that it is applicable to any system of "roller threading," which has hitherto been one of the difficulties with these stop-motions. With the Nottingham, Stockport or Scotch systems it is equally efficacious.

The construction of the mechanism is exceedingly simple, and consists of a thin brass sleeve revolving on and with the bottom roller. The internal diameter of the sleeve is $\frac{1}{32}$ inch larger than the bottom roller, and its external diameter is $\frac{1}{8}$ inch larger than the diameter of the bottom roller. (This increase in diameter and of yarn delivery will be noted later.) Two flanges are formed on the sleeve, and between these the top roller fits freely. One of these flanges has one or two "notches" cut in. (See Figs. 40, 41.)

A small bracket attached to the cap bar "neb" carries a brass or aluminium arm or detecter, bent as shown at D.

The modus operandi of the component parts is: The brass arm rests lightly on the thread running from the rollers to the thread board. The weight of the top roller keeps the sleeve in contact with the bottom roller, and the sleeve revolves with and at the same speed as the bottom roller. Immediately an end breaks the

detecter arm falls and its shoulder comes in contact with one of the "notches," thus stopping the rotation of the sleeve, and in consequence the delivery of the thread. The top roller, being driven by friction from the sleeve, must necessarily stop at the same time.

The distance the detecter arm travels in falling carries the

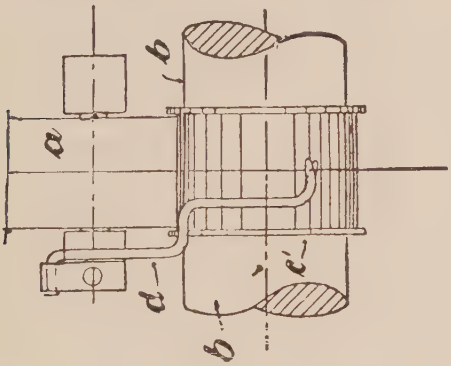

Fig. 41.

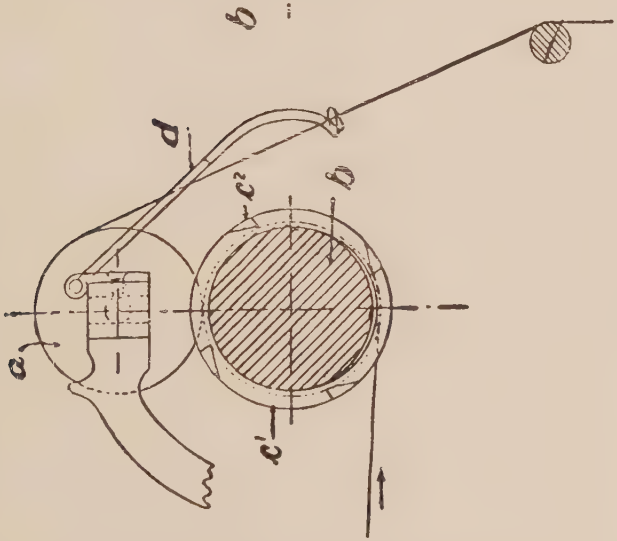

Fig. 40.

thread clear of the next end, and in addition holds it at a tension so that no four-fold can be made. As the delivery of the thread is effectively stopped, so also is the supply of yarn from the creel, therefore, no roller laps can be made.

The detecter arm being the radius of a circle very much larger

than other preventers it moves through a larger arc, for equal variation of tension and slack twist is more readily noticed.

The detecter arm performs another important function in acting as a governor on the traveller through the thread. For example, the drag of the traveller will vary considerably according to the condition of the ring to grease. On a newly greased ring the traveller will revolve most freely and the drag will be less. This slack tension the detecter arm takes up, giving way gradually as the ring becomes dry and the tension more uniform.

In the prevention of roller laps there is further advantage to be noted: the rollers are not cut or damaged, as occurs too often in ordinary practice, by the knives of the doubler when cutting cotton off the rollers.

In most doubling frames, owing to the bottom roller running close to the roller stand bearing, this latter will be found to contain more or less waste, which may have run into the bearing over the roller end and wrapped round the roller shaft, or by careless cutting off of the roller lap some ends may have accumulated there. This naturally acts as a brake, and a considerable waste of horse power is thereby needlessly incurred. As no roller laps can be formed with this patent applied, this fault and waste is also prevented.

It is to be noted that the delivery of yarn from the roller, owing to the increased diameter of the sleeve, will be greater than that delivered from the normal bottom roller, and will consequently give less twist. The remedy for this is obvious, in altering the change wheel and "constant" to suit the increased delivery speed.

No change of cap bar is required, and practically the only time lost in applying it is that required to lift out the bottom roller to slip on the sleeves.

Cotton Doubling. Points to Watch.

Although doubling of cotton yarns is often done to obtain various fancy effects, yet the great bulk of doubled yarn is intended for purposes in which strength is required far in excess of what equivalent single yarns could give. The gigantic industries of thread-making, crochet yarn manufacture, ordinary hosiery, lace-making, and tyre manufacture, are all illustrations of this statement, the yarns being bleached and dyed as required, without any attempt to produce what are termed "fancy" or "novelty" effects.

A doubling mill should primarily concern itself with the character of the single yarn, taking due note and making proper records of such items as amount and direction of twist, colour, strength, elasticity, moisture, and cleanliness of the single yarns.

Corkscrewing has ever been considered a serious defect in producing doubled yarns, not referring now to desired fancy effects.

In corkscrewing, one or more of the single yarns composing the doubled production is, for some reason or another, slacker than its fellow or fellows, and as a consequence twists slackly round the others, and is bad in every way for the next process, being bulky, yet weak, slovenly to operate, and generally a disfigurement.

Corkscrewed effects may be obtained by twisting together threads of different counts, or different twistings, and varies in degree from a scarcely perceptible amount, right up to a totally unworkable product. The use of stop-motion doubling winding frames has proved a great check on corkscrewing for many sorts of work.

The presence of "single" or "double" portions of yarn before doubling, or of snarls, is so much worse for the doubled product. The doubling winder, however, is not always guaranteed to give equal tension on every individual single yarn, and some lace manufacturers yet prefer to use the flyer doubler, and do both the doubling and winding on this machine. It is almost self-evident that corkscrewed yarn needs perpetually guarding against, and when it occurs will leave tensile strain to come upon the tight threads only. Effective use of the doubling winding, with its stop-motion, will check corkscrewing, but on the other hand, the high winding speed of the doubling winder is more conducive to corkscrewing than is the lower yarn speed from the creel of a doubling twister.

In either case, cop bottoms and full cops running together is conducive to corkscrewing.

Every care on the doubling winder should be directed towards having all cop or bobbin skewers accurately adjusted for free ununwinding of the single yarns.

Flannel-covered drag boards to be adjusted to give the correct drag for the yarn counts, and the flannel always in good condition. Drop needles are best of correct counts, although some latitude is permissible in this.

The writer has seen some very soft cheeses produced on drum winders owing to slippage of cheese on its drum, and consequent winding of very open spirals. Such slippage may also affect the shade of the yarn, and cause detrimental friction on the yarn. It is best to have piecing-up of individual component threads, and to avoid "bunch" knots as much as possible.

Like corkscrewed yarn in doubling, snarls are almost always with us in single yarns, and sometimes also in doubling. Snarls in one single yarn out of two or three put together may either show up as a thick place, or may actually project from the produced doubled yarn.

In another place twenty-five years ago, the present writer fully explained about thirty causes of snarls in mule-spun yarn, such

items as quadrant nut too high, fallers unlocking too soon, neglect of nosing motion, irregular rovings, and too much spindle bevel being leading items. Ring-spun yarn is often snarled by slow setting-on or stopping of a frame, travellers too light, or unlevel rovings.

Snarls also may be caused by unskilful handling and careless piecing-up of broken threads at the winding frame itself. Hard twisted yarns are more liable to snarl at winding or doubling machines. The Barber knotter and equivalent contrivances have done a great deal to diminish long knots at winding frames, especially at the vertical spindle winders for single end winding.

Even the doubling twister itself is not free from the production of snarls, especially with hard twisted singles as in voile yarns and others, and with over-ballooning due to very light travellers, or in the case of dry doubling.

Slack strings at every machine containing tin rollers, and spindles driven therefrom by spindle bands, are always to be guarded against at the mule, ring-frame, twiner, ring doubler or twiner doubling machine. Slack strings give soft cops and under-twisted yarns. Better results are obtained when all the operatives are well trained to tie true figure-eight knots, and it is the writer's somewhat bitter experience that "granny" knots are still all too prevalent, and scarcely any trouble is too great that stops their making.

Other items affect twist at the doubler besides slack and wrongly tied spindle bands. The tubes or empty bobbins at the doubler itself are not always kept in the best condition for the work, nor are the travellers always of correct weight.

In wet doubling it happens too often that rings, travellers, rollers and guides are working in a very dirty, untidy condition, anything but conducive to the best results.

The best proportions of twist in component singles and in finished double yarn have lately been the subject of experiment, and frequently the writer has been consulted on this point. Important details of working on the doubling itself are as follows: correct grading of travellers, correct application of suitable grease to the rings of wet doublers, correct proportions of twist, correct spindle speeds, correct creel and guide rod dispositions, satisfactory cleaning, spindle bands of correct tension, spindles well-oiled with really suitable oil, free running top rollers, tin rollers free from vibration, lifter working easily, builder motion accurately set, yarn conducted in the best manner for the work done. In wet doubling, proper arrangements for changing the water, strict attention to the matter of always obtaining the correct material for the creels.

The twiner still finds a place in doubling two-folds for warps and warp-selvedges, as well as some for the lace and other trades.

The flyer doubler still has a vogue for lace two-folds, and has got new life for heavy doublings for tyre yarns; but the ring-doubler is far and away the most used machine for cotton doubling.

One of the faults in doubled yarn consists in staining of the product, and much of this originates with the single. Possible causes of stained doubled yarn consist of: dirty and very large piecings or snarls lashing out at any of the machines, reckless handling of the yarn in transit, over-greasing or careless greasing of the rings at the doubler, dirty steam chests when these are used to condition the single yarns, the all too common fault of threads slipping over the end of top rollers at the doubling frame.

A four-fold preventer is sketched and described on another page. Careless replacement of top rollers after piecing-up of broken ends may possibly cause cut yarn.

Clearer winding, subsequent to doubling, often reveals and remedies a large proportion of defective work from the doubling or twisting frames.

CHAPTER V.

THE TWINER DOUBLING MACHINE.

The twiner ranks with flyer and ring doubling to make up the three types of machine offered for choice to doublers.

The ring doubler is the most used of any being suitable for the thread trade and other extensive lines.

The flyer machine is suitable for heavy doublings. The twiner is esteemed for two-fold warp yarns and other lines, but since the war appears to have lost ground. Few twiners have ever been used in Bolton, some visited by the author in Astley Bridge, and others in Bark Street, having been since discarded.

In its main features the action of a twiner jenny bears a close resemblance to the action of a spinning mule. Any person who thoroughly understands the mechanism of a self-actor spinning mule would have little difficulty in understanding the mechanism of a twiner jenny by the same makers. The chief differences between the two arise from the fact that there are no drawing rollers in the twiner, and the creel has to be constructed to hold cops instead of roving frame bobbins. It is therefore the most convenient plan to allow the creel to travel and the spindle carriage to be stationary, and this arrangement is usually adopted instead of having the carriage to travel, as in the spinning mule. In place of the drawing rollers there is a slide bar arrangement which allows the threads to pass freely through during the operation of twisting, and during backing-off and running-up is locked so as to prevent the yarn from leaving the cops at these periods. The creel is generally arranged so that the yarn is pulled over the cop noses first, but when perhaps three-quarters of the yarn is pulled from the cops the latter are changed to a position in which the skewers revolve and the yarn is pulled from them like roving from bobbins. The skewering of cops is a frequently recurring operation which adds greatly to the work of twiner operatives. Usually two ends are doubled and twisted together at the twiner, and occasionally three ends and sometimes two of the doubled two-folds are twisted together to make a four-fold, but doublings greater than two or three-folds are usually done on the continuous doubler. More recently the skewering has been done on winding frames, making cone-wound bobbins for the twiner creel.

The twiner is well adapted for the two-folds used for warps in the Bradford dress goods trade and for selvedges of warps generally, not requiring a very solid yarn.

Mule spun single yarns followed by twiner doubled two-folds, will give a fuller appearance to the cloth and more cover, than will ring spinning and ring doubling.

Three Rival Machines.

There are chiefly three machines used for the twisting of cotton yarns, as specified below: (1) The oldest machine of all is the flyer throstle doubler; (2) the next in order is the twiner jenny; (3) the most recent and now most used is the ring doubler or ring twister, which almost dominates the vastly important sewing thread trade. The flyer throstle doubler retains its existence by proving very suitable for certain classes of doubled yarns—generally either very coarse or very fine—in which strength, uniformity, and solidity are required, and which do not require anything like high spindle speeds. The twiner occupies a distinctive position of its own in the cotton doubling trade. It is obvious that the ring doubler is based on the ring spinning frame, and it is equally clear that the twiner is constructed on the general lines of the self-acting spinning mule. In each case the most apparent and most important difference consists in there being no draft rollers in the doubling machine—either ring, twiner, or flyer. There are, however, conducting or expression rollers on the continuous machines, but even these are absent in the case of the intermittent or twiner doubler. In the spinning mule there are three primary and fundamental operations taking place during the actual spinning of the yarn, viz.: (1) drafting of the cotton by the rollers, possibly assisted somewhat by the details of "gain" and "ratch;" (2) twisting of the cotton by the spindles; (3) outward carriage travel in order to keep the threads tight. In the case of the twiner there are only two of these fundamental operations occurring during the twisting operation, viz. twisting by the spindles, and outward travel of carriage.

Low Position of the Headstock (Yorkshire Twiner).

Partly owing to the non-use of draft rollers or expression rollers it is found possible and convenient to arrange the headstock of the twiner doubler in a very low position, the rim shaft, backing-off friction, and other parts of the headstock being usually much nearer to the floor than in the case of a spinning mule. There are distinct advantages in this disposition of the headstock as it makes many of the parts more subject to oversight, and more accessible,

although a few of the parts are rather less so than in the spinning mule.

Yorkshire Twiners v. *French Twiners.*

There are two distinct types of twiner doubling machine, the first and more popular type being termed the Yorkshire twiner, possibly from its long and extensive use in some of the textile districts of Yorkshire. The second type is sometimes termed the "French" twiner, and in other cases it is termed the "mule" twiner. The first term apparently arose from the fact that one of our leading machine firms at one time built a good number of this kind of twiner for use in certain districts in France. The second term is clearly due to the fact that this second type of twiner is built very closely on the lines of the spinning mule. In the mule twiner the carriage containing the twisting spindles is traversed about over the length of the stretch just as in the case of the spinning mule, while the carriage containing the creel cops or bobbins remains in a fixed position. Having regard to the fact that draft rollers are not used at all, the headstock is built on lines very much resembling those obtaining in the spinning mule headstock. Very frequently "mule" twiners have been constructed from old spinning mules. In the Yorkshire twiner, however, an entirely different set of conditions obtains in regard to headstock, carriages, and general construction and operation of parts. Instead of the carriage containing the tin rollers and twisting spindles being moved backwards and forwards over the stretch length, this carriage is fixed in a stationary position, and the carriage containing the creel cops or creel bobbins is moved backwards and forwards. A very good reason may be adduced for this special procedure. In the spinning mule it will be remembered that the roller beam, with all the top and bottom rollers, all the wires, hooks, and weights, and all the top and bottom clearers, combine to make mechanical arrangements which would be somewhat difficult to move quickly backwards and forwards through space. Again the clumsy creel for the bobbins would be very inconvenient to move about, while perhaps most troublesome of all would prove to be the bobbins filled with delicate, soft twisted rovings.

A little reflection along these lines will serve to explain why it is better in a spinning mule to traverse the carriage containing the tin rollers and twisting spindles. Further reflection will make it clear that an entirely different set of conditions holds good on the twiner. There are no comparatively heavily weighted rollers and roller beam, there is no creel containing delicate rovings, with the requisite heavy strong spring pieces to hold these. The creel for holding cops of single yarn is by comparison quite light, and the twisted, spun yarn is not near so delicate to handle as the soft

rovings. As a matter of fact the conditions are quite reversed, and it becomes cheaper and easier to move the creel carriage about and fix the carriage containing the twisting spindles in one position.

Both twiner and ring doubling are now often preceded by doubler winding on the stop-motion principle.

The Twiner Process.

The twiner can be more readily adapted to a wide range of counts than the other systems, if such adaptation be required.

The yarn from it when used for warps probably gives a softer and fuller appearance to the cloth.

Fig. 42 is designed to illustrate the action of the twiner. A, B are the fast and loose pulleys of the headstock; C is the rim pulley; Z is the large backing-off friction cone wheel; D is the large guide pulley for the long winding chain, J; F is the fulcrum of the long guide bar or rod, G, used instead of the quadrant to give motion to the radial arm, H.

Referring now to the parts in or near the stationary carriage. Q is the spindle band; R is the large winding drum wheel, gearing with U on the tin roller, V; T is the winding drum; S is the cop of doubled yarn; P is the rail or slip upon which the carriage, L, moves backwards and forwards.

Referring now to the

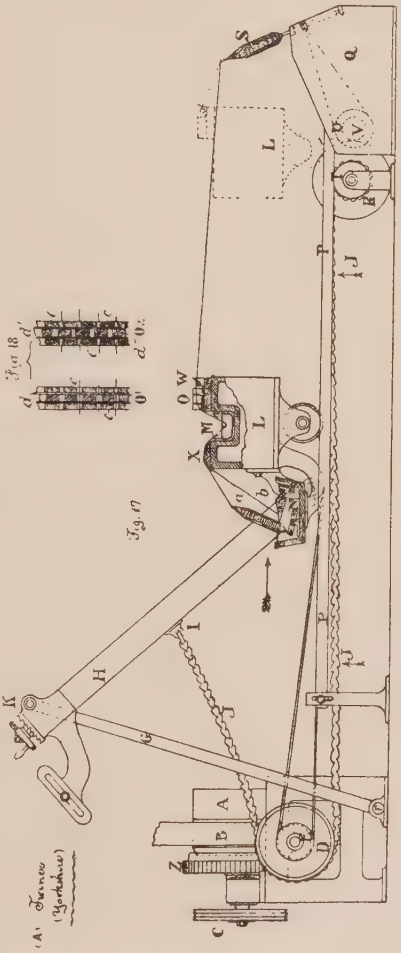

FIG. 42.

movable carriage, L, shown midway between its extreme positions. *a*, *b* are the two cops of single yarn, one of which is shown a little inclined from the vertical, and the other almost horizontal, both positions being more or less used, the first for full cops and the second position more especially for the cops when most of the yarn is wound off.

Passage of Yarn.

The two threads from the cops *a*, *b*, are passed over the flannel-covered drag-board, X, and together beneath the glass rod or hook in the water trough, M, between the brass locking slide, O, over the drag-board or rod at W, and on to the doubled cop at S.

Thread-Locking Motion.

This is shown separately in sub-figure 18. At O^1 the threads are shown passing freely through the brass snugs, *c*, *d*, while at O_2 they are shown locked ready for backing-off and winding-on. The middle brass rod, *d'*, containing the locking snugs, is made to slide into position, Q, when the carriage gets out, thus locking all the threads.

Driving of Spindles and Carriage.

One of the distinctive features of the gearing of the Yorkshire twiner consists in driving both the carriage and the rollers from the rim band. The rim band drives the tin rollers in the well-known usual way, and then the drawing-out shaft is driven directly from the tin roller shaft. This combination drive introduces at least two important corollaries: (1) A larger rim-pulley increases production by increasing speed of carriage and spindles equally; (2) slippage of rim band does not affect the twist per inch, but only means so much reduced production.

In the self-acting spinning mules a great deal of attention has been given to this particular problem of rim-band slippage during recent years, and various devices have been more or less used with a view to reducing the slip on the one hand, or preventing any ill effects therefrom on the other hand. The introduction of treble-grooved rim pulleys is an example of the first-named tendency, and there is no doubt that rim-band slippage is very much less likely to occur with treble than with double-groove rim pulleys, although it is quite certain that the treble groove adds distinctly to the power required to drive the mule. The writer has seen this practically demonstrated in the case of a very short mule, which could not be got to wind solidly and regularly with a double groove rim band, but behaved quite rationally when treble grooved pulleys were substituted. Using a twist-motion operated from the tin

roller shaft is an example of a successful device for preventing any loss or variation in twist due to slip of rim band on a spinning mule.

The usual method of driving the drawing-out shaft from the tin roller shaft is by means of three small driving wheels and three large driven ones, so that the high speed tin roller shaft is enabled to drive thedrawing-out shaft at a very low speed rate.

Working Dimensions (Fig. 43).

We will assume two pairs of twiners in one room to be driven from one short line shaft, and that shaft to be driven by a wide, thick belt from an electrical motor of 40 horse power, with its shaft making 550 r.p.m. There is a 12-inch pulley on the motor driving to a 24-inch drum on the line shaft. Also on the line shaft is a drum 30-inch diameter driving by belt to fast and loose pulleys of 18-inch diameter on the counter shaft. On same counter shaft is 28-inch drum driving down to fast and loose

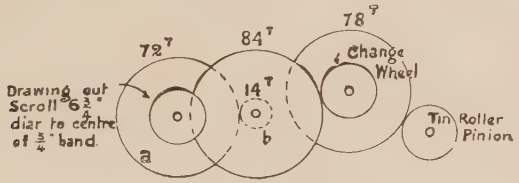

Fig. 43.

pulleys of 16-inch diameter on the rim shaft. The rim pulley is 15-inch diameter, and drives a tin roller pulley of 10-inch diameter.

Tin roller pinion 20, driving a 78 wheel on first stud; change wheel 30 driving a second stud wheel of 84 teeth; on same stud a pinion of 14 driving a wheel of 72 teeth on the drawing-out scroll shaft; the drawing-out scroll on same shaft is 6¾-inch diameter, reckoning to the centre of a ¾-inch band, 6-inch tin roller. From the foregoing list of sizes calculations are given below (see Fig. 43).

1. $\frac{550 \times 12}{24} = 275$ r.p.m. of line shaft.

2. $\frac{275 \times 30 \times 28}{18 \times 16} = 802$ revolutions rate per minute of rim shaft.

3. The revolutions rate per minute of the spindles, without allowing for any slippage of spindle bands, will be found by the next calculations, taking the spindle wharve at $1\frac{3}{16}$ inch diameter.

(*a*) $\frac{802 \times 15}{10}$ = 1,203 revolutions of tin roller.

(*b*) $\frac{1203 \times 6 \times 16}{13}$ = 8,880 = rate of r.p.m. of spindles.

4. Having carried to an end the calculations relating to spindle speed, we may do the same for the drawing-out shaft :—

$\frac{1203 \times 20 \times 20 \times 14}{78 \times 84 \times 72}$ = 21·4 r.p.m. rate for the drawing-out shaft.

5. $\frac{21{\cdot}4 \times 6{\cdot}75 \times 22}{7}$ = 453·98

or, say, 454 inches per minute as the rate of peripheral speed of the drawing-out scroll, and therefore of the carriage which is pulled about by these scrolls and ropes.

We now arrive at a method of determining the very practical calculation of twist per inch, since we have made it out that the carriage moves at the rate of 454 inches per minute, and the spindles at the rate of 8,880 r.p.m. :—

$$8{,}880 \div 454$$

= 19·5 twists per inch put in the yarn from dimensions above tabulated.

6. If this twist per inch does not meet our particular requirements we may obtain the proper change wheel for twist by a very simple calculation. Suppose we only require 16 5 turns of twist per inch, and we now have on a 30 wheel. Find wheel required. It must be noted that a larger wheel will give fewer twists per inch because it will increase the carriage speed without affecting spindle speed.

$$\frac{19{\cdot}5 \times 30}{16{\cdot}5} = 35{\cdot}4 \text{ wheel required.}$$

Size of Rim Pulley.

Both in regard to spinning mules and twiners it has become well understood that the former practice of large diameter rim-pulleys—say 22 or 23 inches—combined with a low speed of line shaft, is unsound in principle. For such a large diameter it could be argued that it acted as a fly-wheel, and gave momentum to the rim shaft. The unfortunate feature in this connection is that the rim shaft must be brought to an absolute standstill three or four times a minute, so that backing-off may take place, and then when winding-on is finished it must be again got up to a speed of possibly

700 or 800 r.p.m., or, say, 500 to 600 when large diameter rim pulleys were used.

Principally for this reason it has become the practice to use rim pulleys seldom exceeding in diameter that of the fast and loose pulleys on the rim shaft, and to get up the speed by chiefly having the line shaft making a greater number of r.p.m.

Twist Calculations.

From the following particulars of the gearing of a twiner, find (*a*) size of twist wheel to give 30 turns per inch, (*b*) size of rim pulley to run three draws in 51 seconds, allowing 4·4 seconds per draw for backing-off and drawing-up. The pinion on the tin roller shaft contains 15 teeth, and gears into a wheel of 78 teeth, which is compounded with the twist wheel. The twist wheel drives a wheel of 84 teeth, compounded with which is a pinion of 14 teeth, driving the back shaft wheel of 72 teeth. The back shaft scrolls are $6\frac{3}{4}$ inches diameter to the centre of the band. The tin roller pulley is 11 inches diameter, the tin roller is 6 inches diameter, and the spindle wharve is $\frac{3}{4}$ inch diameter. The rim shaft speed is 860 r.p.m., and the length of stretch 70 inches.

Answer: First part:—

$$\frac{70 \times 7}{6{\cdot}75 \times 22} = 3{\cdot}299 \text{ revolutions per draw of back shaft.}$$

$$70 \times 30 = 2{,}100 \text{ revolutions of spindle per stretch.}$$

$$\frac{3{\cdot}299 \times 72 \times 84 \times 78 \times 4 \times 6}{14 \times 15 \times 2100 \times 3} = 28{\cdot}2,$$

say, 28's twist wheel without allowing for slip of spindle band.

Second part: In 51 seconds the spindles make $2{,}100 \times 3 = 6{,}300$ revolutions, less revolutions lost during backing-off and taking-in, or less number of revolutions made in $4{\cdot}4 \times 3$ seconds. That is, the rate of revolutions of spindles equals 6,300 in 51 less $13{\cdot}2 = 37{\cdot}8$ seconds.

If the rate of revolutions equals 6,300 in 37·8 seconds, then in 60 seconds or 1 minute the revolutions rate will be

$$\frac{6300 \times 60}{37{\cdot}8} = 10{,}000.$$

We have now the revolutions rate per minute of both the rim shaft and the spindles, with also the diameters of spindle wharve, tin rollers, and tin roller pulley, so it is easy to arrange a speed calculation.

$$\frac{10{,}000 \times 3 \times 11}{4 \times 6 \times 860} = 16 \text{ inches.}$$

Driving of Twiner (Fig. 44).

Referring to Fig. 44 L = line shaft.

Belt drive from line shaft pulley to fast and loose counter shaft pulleys, C, on counter shaft, C, S.

A larger drum, D, drives down to the fast and loose pulleys, F, on rim shaft, this sketch assuming a back rim pulley to be used, but many twiners are conveniently arranged with side rims.

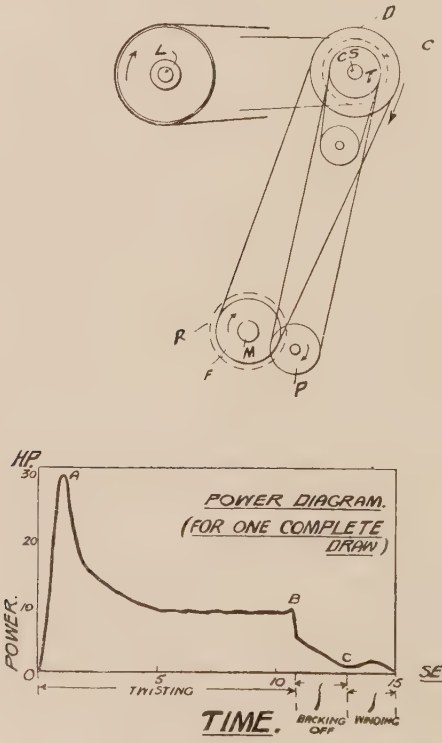

Fig. 44.

From T to P represents backing-off drive by rope.

The lower sketch is designed to illustrate the very important driving principle involved in twiners and spinning mules, in regard to variation in power required during any one complete draw, or cycle of operations.

The starting-out load at A is always very great, the load quickly assumes a fairly regular and moderate amount up to B, drops down very low at C for backing-off; and momentarily becomes nil as the carriage finishes its inward run by its own momentum.

The starting load here is for a spinning mule, and is rather lower for a twiner, owing to no draft rollers being used in the twiner.

The "Strap-Relieving" or Drawing-Off Motion.

One improvement in detail that has proved equally serviceable for twiners, and for spinning mules producing coarse or medium yarns in which supplementary twisting is not needed, is to be found in the case of the strap-relieving motion. The present writer can very well remember the original introduction and development of this particular device, and personally tested it in many ways shortly after its introduction.

On some fast running twiners this principle is utilised to begin moving the belt for as much as 8 inch or 9 inch or more before the carriage gets fully out. The mechanical principles involved in carrying out the operations of a strap-relieving motion may be briefly explained as follows, without reference to any particular make of twiner and without using any sketch. The down belt may be held on the fast or twist pulley by means of a spring, or if there is a combination of springs for moving the belt both ways, then the one tending to put the belt on the fast pulley is the stronger so long as no force is applied from the moving carriage or equivalent mechanism. Moreover, the belt shall not be positively held on the fast pulley by any latch, any connection to the long lever, or any connection to the cam shaft, unless such block motion shall be capable of removal whenever required for belt changing purposes.

Assuming then the belt is merely held by a spiral spring upon the fast pulley, and assuming we want a rather large amount of relieving action for a quickly running carriage, then 7, 8 or 9 inches before the carriage gets full out, suitable brackets on the moving carriage may begin to move the belt from fast to loose pulley, and may actually complete the full movement of belt before the carriage gets fully out.

On cam shaft machines, before the introduction of this strap-relieving motion, the carriage practically co npleted its outward traverse before the cam shaft was changed, and then the belt was transferred suddenly from fast to loose pulley. With the present system of anticipatory movement of belt two or three important advantages are secured. In the first place the carriage is brought to a standstill in a comparatively gentle manner at the finish of the outward traverse, and anyone familiar with the operations of

a twiner with wet doubling, and the water trough fitted into the travelling carriage, can well understand the advantage of this steady finish. On very many occasions considerable trouble has been given to the twiner minders and the overlookers owing to some of the water being shaken out of the troughs at the termination of the outward carriage travel.

In the second place it is no mean advantage to have the belt moved upon the loose pulley before the carriage gets out, in regard to easing the work of the backing-off friction. It is well known that any ordinary backing-off friction has to act more or less as a brake to help to stop the spindles and tin rollers, before the friction can reverse the direction of rotation of these parts. The anticipatory movement of the belt allows a good deal of the force and momentum in the rim shaft, tin rollers, and spindles, to subside in a natural manner before the friction is put into gear. Several mechanical advantages follow this particular effect, such as reduced friction and reduced heating of the friction and friction cone, longer life to the friction, and last but not least, a distinct saving in time required for backing-off. If it is found that a slight loss of twist results from changing the belt very early, then a tooth or so more twist should be inserted by altering the proper wheel in the carriage middle piece.

The Radial Arm, or Scissors Motion.

A distinctive feature in the headstock of the ordinary Yorkshire twiner consists in the employment of a radial arm for governing the winding-on revolution of the spindles without using the quadrant or quarter section of a large spur wheel, and without the small pinion which drives the quadrant in a spinning mule. The long arm or trough, with its long screw or worm, is used in just the same way as on the spinning mule, and it usually carries a nose-peg arrangement, and the long screw is automatically turned by a governing motion cord, in just the same way as on the spinning mule. There are no quadrant bands or front quadrant shaft, and the mechanism is in this way distinctly simplified. The very long radial arm has its lower extremity fulcrumed in the travelling carriage, and instead of its upper extremity moving forward in the direction of the carriage, it is depressed somewhat in the opposite direction as the carriage moves inward and takes the lower end of the radial arm in the same direction. The upper end of the radial arm may be linked to a long lever fulcrumed near the floor, with the effect that the two long arms are opened as the carriage moves in, and are closed as the carriage comes out in a somewhat similar manner to the opening and closing of a pair of scissors, hence the term occasionally employed to designate this mechanism, viz. the

"scissors motion." The winding chain is an exceedingly long one, since it is first carried backwards, away from the moving carriage, until it has been conducted round a large front carrier pulley, before passing in an almost straight horizontal line to the tin roller carriage. This straight line of chain is maintained without alteration in angle or length for all sizes of cop, and it is the shorter length extending from the carrier pulley to the radial arm, which is increased in angle and also in length as the twined cops increase in diameter, and the nut is moved up the screw. As stated, all the principles obtained from the mule quadrant are obtained from the radial arm of the twiner doubler, and, if anything, in a somewhat similar manner. The automatic governing motion can be applied and adjusted to produce the utmost uniformity in the winding-on, in a very automatic manner, although the writer has often seen these motions more carelessly operated and adjusted on twiners than on spinning mules. Very frequently the old nosing arm and nose-peg are retained on the twiner, and are very often still operated by hand, instead of using one or other make of automatic nosing motion.

Backing-off Chain.

Various detail mechanisms are much the same on the twiner as they are on the spinning mule by the same makers, and such mechanisms have been equally improved for both types of machine.

Of such a character are the nosing motions, governing motions, backing-off chain tightening motions, and similar mechanisms. In the case of the twiner, for example, special attention has been given to the backing-off connections. Apart from the questions of diameter of backing-off cone or independent backing-off, the shape of the cam or snail has received special attention in order to bring down the winding faller wire in the same proportionate speed as the yarn is uncoiled from the spindles. This particular problem has frequently exercised the minds of practical men, and various opinions are entertained in this connection. The problem is complicated by such factors as the height of the faller wire in relation to the spindle points prior to backing-off, the varying diameter of the spindle, the pitch of the spirals of yarn upon the spindle blade, and the increasing length of cop from bare spindle to full length.

In spite of these factors a modern twiner is usually supplied with mechanism which can be made to give excellent results when utilised in an intelligent and practical manner. In one specific instance of twiner it is claimed that "the improved backing-off motion works throughout the whole of the cops without any aid from the attendant. This motion is obtained by means of a cam introduced to work along with the ordinary backing-off chain

pulley; the cam, being made to imitate the coils of yarn upon the bare spindle, brings down the faller wire just in the same ratio as the yarn is uncoiled from the bare spindle."

In this connection there are advocates for the practice of having the backing-off chain always tight at all stages in the cop building; others who maintain that the chain should be slack at the commencement of a set of cops, and tight at the finish; and yet others who would have the chain always following the yarn down the spindle, excepting just before the actual locking of fallers, and would then utilise a cam or projection on the backing-off snail in order to give a forcible finish with a tight chain. It is obvious that a close relationship and proportion must subsist between the uncoiling of the yarn from the spindle and the downward speed of the faller wire, if we are to obtain the best results in regard to cop-building and production combined with the minimum of thread breakage.

Double yarn on the twiner, with a good balance of twist per inch in both single and double yarn, ought to withstand a reasonably tight backing-off chain, without leading to thread breakage. It is astonishing in how many cases firmer cops and better cop noses have been obtained by a skilful and careful application and operation of backing-off chain tightening motions, whether automatic or otherwise.

Twisting.

In regard to the twisting problem on the twiner it must be remembered that doubling from cops and making into two-folds have been very commonly practised on this machine, these two-folds being frequently utilised for warps or the selvedges of warps. To some extent it is a matter of arrangement in particular cases as to direction of twist in the single and the double yarns. It is well understood that if both spinning machine and doubling machine have their spindles revolving the same way, a very curly intractable doubled yarn is produced, and so it is common to have the twiner spindle revolving in the reverse way from that of the spinning machine. For example, the single yarn might be spun twist way, and the doubled yarn at the twiner might be weft way or reverse. The opposite method adopted if required.

We might, for example, in the case of selvedge yarn for warps —as used for some classes of plainly woven narrow cloths to be afterwards printed—insert twist in something like the following proportion: In single yarns the twist = $\sqrt{\text{counts}} \times 3\frac{1}{2}$, the spindles revolving twist way. Then at the twiner $\sqrt{\text{counts doubled}} \times 3\frac{3}{4}$ or 4, with spindles revolving reverse or weft way. We may thus from ordinary American cotton obtain a good two-fold yarn

quite strong enough for use as warp selvedges. There is no difficulty whatever in the twiner in readily obtaining any degree of twist ever likely to be required, either up or down, as the case may be, as it is quite possible to get as low down as half a dozen twists per inch, or up to 8 or 9 times that amount. This may be done by the gearing which connects the tin roller with the drawing-out shaft, as explained previously. Other balances of twist as required.

It would also be easy to revolve the spindles of either spinning mule or twiner jenny, so as to produce any desired effect in regard to twist direction. We might, for example, have spinning spindles twist way and doubling spindles weft way; spinning spindles weft way and doubling spindles twist way; both weft way; or both twist way. It is important also to consider the proportion of twist to be inserted at the spinning machine in relation to the amount of twist at the doubler. There are many sorts of work in which it is important that the single spun yarn shall be soft twisted in order to obtain the best effect in doubling, and this is particularly true in regard to yarns from Egyptian cotton. With American cotton it is often necessary to put in a reasonable amount of twist for the single yarn in order to get sufficiently good spinning, and it is not very often that we can afford to spin such yarn very softly twisted. The extraction of single twist by doubling twist should be duly regarded.

The effect of the twist is influenced in twiner doubling by the question of using steam chests for the single yarn before taking to the twiner, and also by the use or otherwise of water troughs on the machine. It is well known that the single yarn for the twiner is frequently placed in a steam chest for some time, with the object of reducing any tendency to kink or snarl in coming off the cops. This practice has been, however, discontinued by some firms on account of the trouble and expense, the staining effect upon the yarn, and the effect upon the weight.

Passing the yarn through water in a well-regulated manner at the twiner has the result of solidifying the doubled thread and producing a more concentrated effect. Sometimes a proportion of soap-water has been used in the water-trough.

The Copping Motion (Yorkshire Twiner).

In all essential principles the copping mechanism of the twiner closely resembles that of the spinning mule, although there are several distinctive differences in mechanical detail. The copping motion is secured so as to partake in the rigidity given to the headstock by using strong foundation plates of good size. An iron plate spans the foundation plates at the faller shaft end of the headstock, and upon this plate is bolted the copping motion, thus obtaining

great steadiness—a feature formerly deemed of small importance. The short copping rail is preferred, much after the style to be found on fine spinning mules. A very important feature is that the locking lever stops in one position with the carriage, and therefore the short copping rail is moved backwards and forwards beneath this lever so as to give the required traverse to the winding faller wire.

This movement of the copping rail may be very naturally obtained from the radial arm or quadrant, the connection being made by means of a suitable link or connecting rod. To obtain perfect action of the copping rail, without hesitation, loss, or variation in movement, especially at the change points, the jointing and general construction of this connecting rod have been much improved in recent years, and there are no variable quadrant bands to upset the accurate adjustment of the parts. Instead of being canted upon one side, with a single copping plate, the plates are now made double, so as to hold the rail firmly and steadily on both sides. Experience has taught the value of such details in making solid, well-shaped cops, with good top and bottom cones, free from ridging, containing a maximum length of yarn, and capable of readily straightening if the cop noses become halched. Methods of lengthening or shortening the top and bottom cones of the cops, or of obtaining a true cylinder on the cop, or a true shape to the upper or lower cone, are the same in principle as they are on a spinning mule. It must be remembered that in a short rail, which seldom has more than 16 inch or 17 inch length actually operating against the locking lever, there is much less filing required than on a long rail in order to obtain a given effect, and also any alterations in the back copping plate will have much more effect on the ridge or highest point of the copping rail than would a corresponding alteration for a long rail.

Such details as loose front inclines for the copping rails, and fine adjustment screws, also add to the virtues of the copping motion on modern twiners. If harder cops are required then more faller weights may be applied, or the winding faller shaft drawn farther from the spindles, so that the wire only just misses the spindle points in backing-off, or the length of the chase or top cone of cop may be increased, or the backing-off chain may be tightened, or there may be a readjustment of the radial arm, or the nosing motion may be applied somewhat more keenly. Almost all these things would also tend to make better cop noses. The minder should be held responsible for soft cops due to slack spindle bands, and for nicked cops due to ends being left down for some time, and then pieced up again without pushing up the cops.

If the base of the cop cylinder is too thin, and the bottom cone of the cop is too short and thin, we may put more of both plates into action, or possibly more only of the front plate, and it must

be remembered that we keep on forming the bottom cone until the nose or change point of the front plate has passed from beneath the stud of the copping rail.

The exact adjustment of the sector in relation to the faller wire, exercises an important influence on the cylinder of the cop, and in cases where the base of the cop cylinder is of different diameter from the upper portion it is advisable to examine this point before going to the extreme of filing the copping rail or copping plates. Briefly it may be stated that when the centre of the sector stud is in the same horizontal plane as the centre of the winding faller shaft, and the mule partly backed off, a line extended at right angles through the centre of the working length of the spindle blade, should pass through the centre of the faller shaft, or somewhere very near to that.

A thorough scouring and re-flanneling of the drag boards is sometimes necessary on the twiner in order to maintain the quality of the yarn, obtain good hard cops, and prevent excessive breakage of the threads. This is especially true for wet doubling since there is a continual tendency for dirt and rust to accumulate on parts which affect the passage of the yarn. At scouring times the brass locking slides should be lifted out, and the water troughs, the travelling carriage, and other parts should be well scraped and cleaned. On such occasions it is a very common practice to renew the flannels of the drag boards, and the overlooker should take advantage of the stoppage of the twiners, in order to make any needed repairs to the headstock or other parts of the machine. It is just as important on a twiner as on a spinning mule to have the taking-in friction, backing-off friction, and cam-shaft friction kept in good order, and the parts thereof adjusted to the best advantage. Ball drag has been applied to some twiners.

Specifications.

"The rim shaft can run at a high speed, and a very large variation in the twist is obtainable. Large pulleys are used throughout, and all the working parts are solid and substantial, as well as carefully made." "The position of the drawing-out scroll has been altered so as to bring the band into a perfectly horizontal position in place of the usual inclined one." "An improved tightening motion has been introduced for quickly getting the tension of the taking-in bands. The tin roller pulley and the winding and backing-off ratchets are made in two halves."

"The creels are made in various forms and for doubling from cops or ring-frame bobbins, and also to take bobbins from the winding frame." "The faller shafts are made with anti-friction bowls for the shafts to run on."

A query paper runs as follows : " Number of twiners ? Number of spindles in each ? Distance of spindles ? Revolutions of main shaft per minute ? Diameter of drums on main shaft per minute ? Diameter of fast and loose pulleys on counter shaft ? Diameter of drum on counter shaft ? Length of counter shaft ? Driven from above or underneath headstock ? Length of draw or stretch ? Length of spindles ? Diameter of spindle wharve ? Length of spindle out of bolster ? Speed of spindles ? Twist per inch ? Zinc or brass guides ? Covering-in boards over tin rollers to be hinged or in one piece ? Width of list boards ? Are plummel weights required ? Numbers to be doubled ? For what counts is the twiner to be started ? Creels ? Length of skewer ? With or without water trough ? Price per spindle ? If driving apparatus extra ? If water troughs extra ? If patent tightening apparatus for rope taking-in extra ? If to be fixed on stone floor ? Plate bolster ? Harcastle's patent continuous creel ? When must the machines be delivered, and how ? "

Twiner carriages are now built in a substantial and rigid manner from carefully selected and seasoned timber, fitted with diagonal rods of good diameter. There is less danger from fire on twiners than on spinning mules because of the use of wet doubling and the absence of the inflammable creel bobbins of roving, and also the absence of much loose fluffy waste. Tin roller bearings are specially arranged for oiling when at work, and are of special construction for easy running. Self-lubricating footsteps and bolsters for the spindles may be used if required, but are counted as extra in cost. In some cases the rim shaft is supported back and front by steps 5 inches wide, the shaft itself has the rim block forged on, and when turned and finished, is case-hardened all over, and is also fitted with lock nuts to prevent any movement end ways. Various styles of patent loose bolsters are more or less in use.

Bands and Faller Wires (Figs. 45 to 48).

In Fig. 45 the tin roller pulley, C, is driven by band as usual, and the tin rollers drive the spindles by part crossed bands. S = spindle, W = wharve.

In Fig. 46 the under carriage bands are marked A, A, A, and B, B, B. The large diameter double grooved pulleys P, R, are beneath the carriage.

The sketch (Figs. 47-8) represent the faller wires, C, D, in twisting and winding-on positions respectively.

The sketch in Fig. 49 is designed to illustrate how twist is put into the folded yarn by the latter constantly twisting off the spindle point. At T either paste or tubes may be used for the

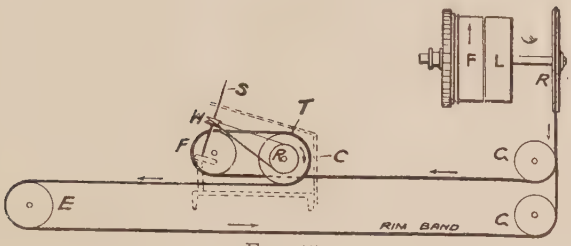

FIG. 45.

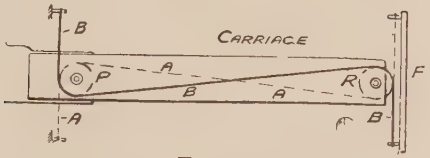

FIG. 46.

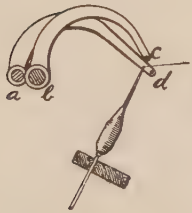

FIG. 47.

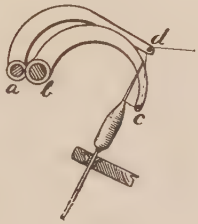

FIG. 48.

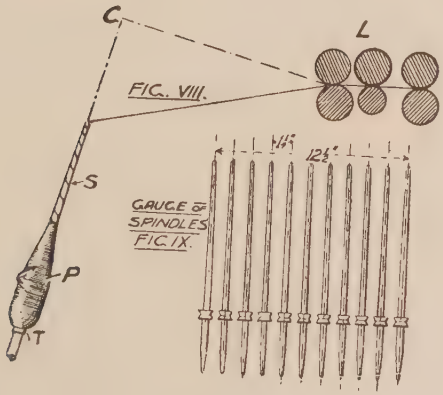

FIG. 49.

cop bottoms. At P is shown spindle revolving twist way, but weft way is probably more common on a twiner.

Spindle gauge as in Fig. 49 may be 1½ inch, but varies within limits.

Creel Arrangements.

It has been a common practice to use double creel arrangements for the cops of single yarns at the twiner. The full cops in such a case are put in a part of the creel which is constructed

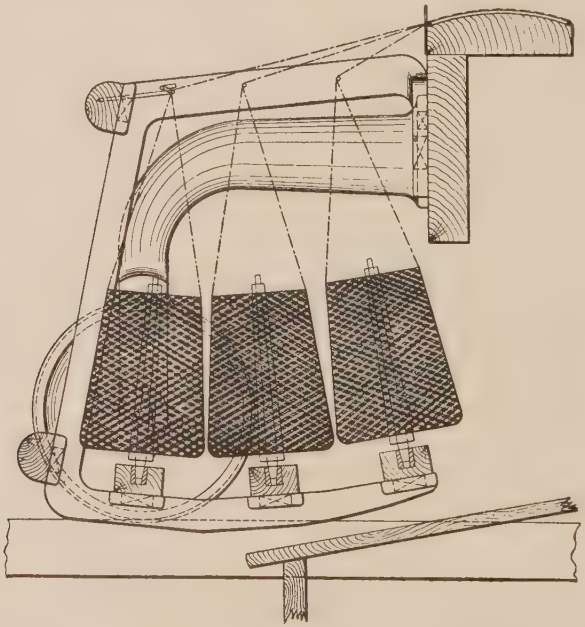

FIG. 50.

to permit drawing the yarn from the end of the cop nose. When the cops are something more than half-used, or are approaching the bottom cone, they are transferred to the second part of the creel, which is constructed to permit rotation of the cops and skewers and side unwinding from the cops. In this method there is the double advantage of preventing thread breakages when the cops are nearly finished, and of making the first half of the creel free for the insertion of the next set of full cops, ready for piecing-up as the preceding cops become used up. In a special device

portions of the double creel are made of a partial turnover kind, with the object of yielding in the case of a person or some inanimate object getting fast between the creel and a pillar, or other fixed unyielding object. In a second device the creels are constructed specially at the points which the carriage bowls come against.

Above and beyond all these devices we have the tendency towards the adoption of the doubling winding frame between the spinning machine and the twiner, this being a system which completely alters the creel and creeling arrangements of any twining in which it is adopted.

In the quick traverse drum winding frame the mule cops are wound together upon conical cheeses, a stop-motion being used so as to prevent any single yarn from passing forward. Moreover, the conical cheeses contain a good length of yarn, permit end unwinding at a good speed, and there is not much trouble in regard to corkscrewed yarns. There is, however, a limit to the benefit.

The reduced labour, greater production, and better yarn from the twiner, probably pay for the entire cost of winding the cone cheeses.

Some twiner firms adhering tenaciously to cop creels lost orders through frame yarn having pleased customers better than twiner yarn, due to frame users more readily adopting preliminary doubling winding frames and thus reducing various defects in regard to piecings, knots, corkscrewing, and single.

Messrs. Asa Lee's twiner creel adapted to use cones is shown in Fig. 50.

Independent Backing-off.

The principle underlying independent backing-off consists in the ability to alter spindle speed during twisting by applying a different diameter of rim pulley, without this change also altering the speed of backing-off. For example, in the case of a spinning mule as ordinarily constructed, if we applied a smaller diameter of rim pulley we should obtain reduced twist per inch in the yarn by simple proportion. At the same time, however, we would have reduced the speed of backing-off in exactly the same ratio since the rim pulley usually drives the spindles, both during spinning and during backing-off. In the same way in the case of an ordinary Yorkshire twiner, a larger diameter of rim pulley would increase production by driving both spindles and carriage more quickly—an effect often required and obtained. The same alteration would also increase the speed of backing-off—an effect often inadvisable from one reason or another. There are various methods in which such a contingency may be provided for in a more or less successful manner, but each method usually introducing factors which

some people consider objectionable for most single or double yarns. For example, it is sometimes the practice to apply separate rope driving from the counter shaft to a cone pulley arrangement, culminating in a small pinion which gears with and drives the large backing-off friction wheel. A good method is to apply two separate and independent rim pulleys, one for driving the spindles during backing-off, and the other for driving the spindles during doubling. Either of these rim pulleys can be altered without affecting the work of the other, so that the speed of backing-off can be altered without affecting the spindle speed during doubling, or *per contra*, doubling speed may be altered without disturbing backing-off speed. The present writer is somewhat inclined to the opinion that successful devices for independent backing-off ought to become an indispensable part of every self-acting twiner or spinning mule.

When a twiner changes to very low twist per inch it is often best to apply a much smaller diameter of counter shaft driving pulley in order to get low rim shaft and tin roller speeds.

Productions of Twiner.

"The productions likely to be obtained from self-acting twiners may be fixed approximately as follows, but these must not be taken as hard and fast figures, as productions depend upon the speed of spindles, twist per inch, skill of the workpeople, quality of the yarn, etc. :—

Counts of Yarn.	Speed of Spindles.	Turns of Twist Per Inch.	Approximate Production in 10 Hours after all Allowances for Loss. Per Spindle.	
			Hanks.	Lb.
	Revs.			
16's 2-fold	7,500	16	4·1	0·512
20's ,,	8,000	18	4·16	0·416
24's ,,	8,500	20	4·25	0·354
30's ,,	9,000	22	4·5	0·300
36's ,,	10,000	24	4·5	0·250
40's ,,	10,500	25	4·5	0·225
50's ,,	10,500	26	4·5	0·180
60's ,,	10,000	27	4·25	0·141
70's ,,	10,000	28·5	4·16	0·119
80's ,,	10,000	30	4·0	0·100

To calculate the length of a self-acting twiner, multiply the number of spindles by the distance, and add 56½ inches.

Width of machine with 70-inch stretch : from back of creel to end of stretch, 8 feet 10⅛ inches with ordinary creel 3 feet 0⅛-inch wide ; from end of stretch to front of headstock, 13¾ inches ; from front of fallers to back of headstock, 11¾ inches.

Use of Twiners.

The origin of the twiner is somewhat uncertain, but possibly the name of "Yorkshire" twiner indicates this county to be associated therewith, and certainly "Yorkshire" twiners are the most used, and their products are sometimes referred to as Yorkshire yarns. If small cops of grey yarn are required for direct use in the loom shuttle in two-cord, then the twiner offers a cheap method.

A few pairs of twiners will be found in many districts, but the towns most familiar with their use are : Oldham and Ashton, and neighbourhoods in Lancashire, Halifax, Sowerby Bridge, and Brighouse in Yorkshire. Twice over the writer has been in touch with twiners in the Bolton district, but it is doubtful if there are any left at time of writing, although Bolton is a large centre for doubling on the ring and flyer throstle systems, as more suitable for lace, sewing, and netting yarns.

The production of doubled yarn in cop form and the more open, oozy nature of the product, have helped to maintain the use of the twiner for weaving purposes.

Cops of single yarn for the twiner creel were long in use after the doubler winder had won its place for ring doubling, but twiners now also more often use cheeses or cones in their creels. For some sorts of soft twisted two-folds the twiner has often been found cheaper than ring-doubling.

Gassing from large bottle-shaped clearer bobbins has largely superseded gassing from twiner cops of two-fold yarns.

Mercerising of two-folds is also more successful when the doubling winder has been used, as the tension applied in mercerising is better withstood by the more level product.

Twiner twisted two-folds for mercerising, appear to be giving way to frame-doubled two-folds.

Notes on Twiners.

A twiner may be fitted with a full cop stop-motion if required, which acts after a certain number of draws have been made. There are twiners in which the twist may be varied from two to forty turns per inch. Tin rollers may be oiled with machine working. Self-lubricating bolster and footstep bearing may be applied to spindles if desired. Carriages may be fitted with diagonal rods as for spinning.

The rim block is usually forged on the rim shaft, and the rim shaft may be supported by bearings 5 inches wide.

Locking slides may have both top and bottom parts made of brass and the top can readily be lifted out since its own weight is sufficient to keep it in working position. Locking of threads usually takes place simultaneously with carriage getting fully out but is adjustable, and may take place an instant sooner in order to put drag on the threads, this being often an advantage.

The quick traverse doubling winder used before taking the yarn to either the ring doubler or the twiner doubler, is of immense service in preventing "single" and "corkscrewed" yarn, and in reducing labour and giving better work at the twisting process.

Banding for Yorkshire Twiner (*Hetherington*).

Taking-in scroll band . .	$\frac{7}{8}$-in.	dia., 15 ft. 6 in.	long.
Long drawing-out band . .	$\frac{5}{8}$-in.	,, 17 ft.	,,
Short ,, ,, . .	$\frac{5}{8}$-in.	,, 15 ft.	,,
Check band	$\frac{9}{16}$-in.	,, 15 ft. 6 in.	,,
Rim band	$\frac{9}{16}$-in.	,, 56 ft.	,,
Taking-in bands . . .	$\frac{9}{16}$-in.	,, 46 ft.	,,
Band for the governor motion	$\frac{7}{16}$-in.	,, 15 ft.	,,
Squaring bands: 3 required .	$\frac{7}{16}$-in.	,, 9 ft.	,,
,, ,, ,, ,, .	$\frac{7}{16}$-in.	,, 11 ft.	,,

Net Weight of Twiners.

Yorkshire twiners, 72-inch stretch :—

Headstock, square, and ends . . . . . 3,888 lb.

Remainder of the machine, $1\frac{5}{8}$-inch gauge, $9\frac{1}{2}$ lb. per spindle.

Top driving not included in above weights.

To obtain approximate gross weight, add 26 per cent.

Gearing.—The space occupied by the gearing is 4 feet $9\frac{1}{4}$ inches less twice the gauge.

Driving Pulleys, usually 16 inches diameter × 5 inches wide.

Mule or French Twiner, with stationary creel, the gearing occupies 4 feet $4\frac{1}{2}$ inches.

The headstock rests on planed bed plates, which are arranged to carry the radial arm, cop builder, and other bearings, combining the whole in a very rigid manner.

Distribution of Twist.

For American cotton spun without "ratch" or "gain" the writer has sometimes found ring yarn to be more uniformly twisted than mule yarn.

The stock argument with some people is that a mule spinning

or a twiner doubling machine will always necessarily give unequal twist because the twist has to run from the spindle point along the 63 to 70 inches of yarn reaching from spindle point to nip of roller. The writer has seldom been able to find much variation to speak of in either case especially in class yarns, and does not agree with the contention that a ring spinning or doubling machine gives more uniform twist than the intermittent system so long as the cotton and counts will permit of carriage gain and ratch. For lower counts and American cotton ring-frame yarn often shows up better in a twist test.

It is possible to utilise "ratch" and "gain" in mule spinning, and it is also possible to apply tension or drag in the twiner by locking the threads before the carriage gets fully out. These factors help to distribute the twist uniformly. It is not denied that tests of mule yarn often reveal more twist in one part.

Arrangement of Twiners.

Twiners are best arranged in pairs as in the case of spinning mules, and may be about the same length of spinning mules, although often somewhat shorter. 950 spindles long × 1½ inch spindle gauge is a good length.

For 40's to 50's two-folds a twiner may run four draws in 56 seconds or 14 seconds per draw, taking 9 seconds for twisting, 2 seconds, backing-off, 3 seconds taking-in.

Cops creels have been giving way to cheese and cone creels for some time. With cops of single yarn the cops are first fixed in a portion of creel which allows correct drawing-off over the cop noses. When cops are about half-way or more used they are transferred to a second creel which provides side unwinding and also leaves the first creel clear for fresh full cops of single yarn. With cheeses or cones in the creel, each cheese contains as much yarn as several cops, and there may also be either end or side unwinding.

"Stretch" means distance that carriage travels one way. "Draw" means one complete cycle of operations and one complete backward and forward movement of carriage.

Twiner Arrangements.

The Decker system of mule spinning—in which two short carriages not in line, but parallel to each other—are driven from one headstock, has been also occasionally applied to twiners.

Twist is put into yarn by the spindle perpetually winding the yarn around the spindle point, and then permitting the yarn to come over the spindle top or point; bevel of spindle, taper of

spindle, and spindle point being lower than delivery or nipping point all helping in this twisting over the spindle point (see Fig. 49).

Although a full length twiner may be as long as a full length spinning mule, yet the creel carriage is comparatively light and only one drawing-out and one drawing-in band may be essential.

The well-known under carriage bands or squaring bands appear to be sufficient to keep the traversing creel carriage in a straight line without the need for a long back shaft and the several pairs of carriage bands. The under carriage bands may, however, be extended a little more than usual, by having a carrier pulley placed under the middle of each half-carriage, and the ropes or wires threaded so that a double squaring action is obtained, and there is not only a carriage squaring effort obtained at the ends of each half-mule carriage but also in the centre of same.

A twiner cop may have dimensions equal to those of a full twist size mule cop when $1\frac{3}{8}$-inch gauge is used, and larger in proportion if $1\frac{1}{2}$-inch gauge.

The top or sliding half of the thread-locking device is usually latched in position by a suitable bracket on the carriage as the latter gets fully in.

Equally the latch is removed when the carriage is nearly out again, so that a strong spiral spring at once moves the bars into locking position.

The nippers are closed gradually to avoid damage to the yarn, but no such precaution is exercised in opening them.

Conditioning.

Twiners may be either wet or dry doubling. Usually the faller wires are of the mild steel kind used for spinning mules, but sometimes brass faller wires are used for wet doubling to prevent corrosion. Twining often demands more conditioning of single yarn than other processes.

Twining from cops of single yarn is frequently preceded by steaming of the cops in a steam chest for several minutes, in order to take out snarls and make the threads more solid and workable. The modern practice of using cones or cheeses scarcely needs the steaming process since any desired drag or tension may be applied in doubler winding, but conditioning without steam may be advantageous.

The essential feature of steaming consists in placing the skips or boxes of cops of single yarn inside a special chest, close the lid or door to make it steam-tight, inject steam into the chest, and leave the cops under steam for possibly 15 minutes or so—the time varying. To make steaming more effective, easier, and more likely to give uniform effects instead of "stripy" effects special

steaming chests are obtainable. Steaming is a quick method of conditioning the single yarn, but it has distinct disadvantages, and in many modern cases the conditioning is done by other methods without using steam. Such systems as the "Halliwell" and others represent more recent advances in conditioning methods.

Stretch lengths for twiners are much the same as for mule spinning, ranging usually from 62 to 66 inches.

Revolutions per minute of spindles are also much the same in each case for equal finished counts—say possibly 9,000 r.p.m. for 52's/2.

Formerly the present writer had to do with steam chests in which about 30 minutes of low pressure steam was the system. To prevent staining of the yarn and to expedite the process, higher steam pressures have been adopted and improved, steam chests requiring possibly 10 minutes conditioning.

Contraction in Doubling.

The insertion of twist always tends to contract the yarn in length.

Twist testers are readily applicable for ascertaining the twist per inch in doubled yarn, but are somewhat more awkward to handle for twist testing in single yarns. Referring to doubled yarns the contraction is greatest when the doubling twists are the same way as the spinning twists, and least when doubling twist is the reverse of spinning twist. When a doubled yarn is untwisted in the tester, the yarn may become slack to an extent proportionate to the previous twisting contraction. Doubled yarns for mercerising or hosiery will be more softly twisted than heald yarns, lace yarns, voile yarns, and sewings, speaking generally.

Contraction or shrinkage is affected by amount and direction of twist at any or every stage. A good well-s t or balanced doubled yarn is obtained by having correct proportions of clockwise and anti-clockwise twists at different stages. Contraction means lowering of yarn counts.

Gain of carriage in mule spinning, heavier travellers in ring spinning or doubling, and early closing of the locking slide on a twiner, are all limiting factors of contraction.

The Twiner.

Twiner two-folds are not subjected to the drag and tension of travellers as in ring doubling, or of bobbins in flyer doubling, and the twiner yarns are, therefore, less concentrated or solid, and not so strong. The twiner yarns, however, are not stained by traveller grease, and give a fuller appearance to some goods. Also they

have been considered to cost rather less to produce, and suit some customers who prefer their doubled yarn in cop form. Medium and fine two-folds from 40's to 180's single yarns have afforded good scope for twiner doubling. For the most part the market for twiner yarns differs from the market for frame yarns in one respect or another. Use explains the retention of the twiner in many places.

CHAPTER VI.

PRINCIPLES, PURPOSES, AND PRODUCTS OF COTTON DOUBLING.

Introduction.

Ply yarn, folded yarn, double yarn and doubled yarn, are terms applied more or less to threads produced by doubling and twisting two or more individual yarns together.

The term doubling is applied to the process even when the individuals are only twisted together at one machine, and the actual placing together has been done at a preliminary doubling winding machine, this being an ever-increasing custom.

All experience proves that spinning yarns finer, and then twisting them together gives a far superior finished product than can be obtained by any known means of directly spinning the thread to the required final counts and thickness.

For example, it is not practicable to spin a single yarn of 10's, 20's, or 30's counts, to be equal in resistance to abrasion, set, and wear, to the resultants obtainable from 20's/2, 40's/2 and 60's/2 respectively. Snarls, bad ends, and other defects in single yarn, seriously weaken the two-cords. When the final thread is obtained by only one process of doubling the doubling twist is usually, but not invariably, the opposite way to the spinning twist, and one doubling twist extracts one spinning twist from each single yarn.

If the spinning and doubling twists are regulated with care, skill, and ability a balanced, tractable, nice-looking resultant doubled yarn is obtained by opposite twisting, whereas doubling twists and spinning twists all the same way would give an intractable thread, always trying to untwist itself at every opportunity, if left at that.

If too much twist is put in the spinning process, extra twist is needed in reverse doubling, to obtain a correct balance.

Fundamental Factors in Doubled Yarns.

Amount and direction of twist in single yarn and in doubling respectively, proportions of one to the other, whether doubling

twist is the same way or opposite to spinning twist, whether "cabling" is utilised in doubling, or instead, the doubling is done in one operation instead of two, counts of single yarn, number of single ends put together in doubling, use or otherwise of doubling winding frame, kind of cotton used for single yarn, whether the cotton has been combed, whether is done at all, or is done before or after doubling, the use of plain or of dyed yarns, whether doubling is done on the ring, flyer or twiner doubler, wet or dry doubling. Doubling is done to produce yarns superior to those produceable by spinning alone.

Uses of Doubled Yarns.

Doubled yarns may be used either for warp or weft in good descriptions of cloth, but more especially for warp or selvedges of warp.

Air-craft cloth is an example of doubled yarn being used both for warp and weft, such cloth being required to pull a certain strength, in a certain small sample, both weft way and warp way. Dress goods, pile cloths, and men's cord trouserings are examples of the use of doubled yarn in warps; machine twists, knittings, fish nets, cord, twine, crochet yarns, sewing thread, lace yarns, voiles, ties, socks and stockings, healds for looms, embroidery yarns, tyre yarns, sail cloth, tent cloth, hosiery, gloves, poplins, fancy or novelty yarns, coverings for electric and other wires; these are all examples of the special uses of doubled cotton yarns, and do not by any means exhaust the list.

Experiment. Proportion of Double to Single Twist.

Among doubling men the question has often arisen as to how far the doubling twist affected the single yarn twist, and many years ago the author devised a little experiment as follows:—

Take 10 to 12 inches of ordinary three-strand spindle banding, count the twists per inch, and fasten two of these in an ordinary 12-inch twist tester, so that they can now be twisted together.

Apply twist to this thick two-cord in the opposite direction to any extent desired. With the machine fixed cut away one of the two component parts, and again count the twists in the original and remaining spindle banding.

Such tests and examinations led to the understanding that every opposite doubling twist extracts one twist from the single component.

This factor exercises tremendous influence in producing doubled yarns.

Balance of twist in a doubled yarn has before now been explained to mean that the twists one way in component threads

shall bear such a proportion to the opposite twists in the doubled product that a permanent "set" or fixing of the final thread is produced, having the desired strength and lustre.

Balance of twist has again been defined to mean that the opposite doubling twists shall equal half of the single yarn twists so that the doubling twists shall equal the remaining half of the spinning twists. This is an entirely and mostly an undesirable feature to aim at.

Example.—Assume any single yarn to contain 24 turns per inch, and is made into two-folds with 12 turns per inch the opposite way. Twelve turns per inch would be extracted from the single leaving 12 in each component and 12 in the composite thread.

This kind of balance is seldom desirable.

Again. Suppose two threads of 16's be put together thus producing 2/16 = 8's not allowing for contraction.

The twist constant in each case is taken at $\sqrt{\text{counts}} \times 4$.

1. $\sqrt{16} \times 4 = 16$ turns per inch in single.
2. $\sqrt{8} \times 4 = 2{\cdot}828 \times 4 = 11{\cdot}312$ in the composite thread.
3. $16 - 11{\cdot}312 = 4{\cdot}638$ of original twists remaining in each single.

Any doubler worth his salt ought to make his calculations based on these principles so as to ascertain the number of twists remaining in each component part of a composite thread. By tabulating and comparing the results he may arrive at conclusions in regard to strength, lustre, softness or elasticity in the finally produced thread.

Obviously a very small twist constant in the single, and a very large one in the composite or doubled thread might go so far as to take all the single twists out, or even go to a minus quantity.

The point raised here is of great importance, but is not laboured at this stage, leaving it to be developed to any extent desired by those concerned.

There are very many purposes for which the strength, pliability, and beauty, obtainable from doubling yarns together, are very important. Sewing cottons, embroidery yarns, crocheting cotton, double warp yarns, knittings, mendings, nettings, healds, and lace yarns, for example, are only several out of very many instances for which ply yarns are in immense demand.

Doubling also affords a ready field for obtaining fancy effects in yarns, such as novelty and grandrelle yarns.

If the doubling operation is not carried out with ability, one individual yarn may be slacker than another, and the product will be much weaker, and from this point of view a 20's single may sometimes be stronger than a 40's/2-fold, although not better able

to resist abrasion and wear. Correct proportions of single and doubled twist are always essential.

The expression 60's/2, 30's/3 are probably more used than 2/60's, 3/30's, but both methods are in use.

Cabling.—This may be defined as "the doubling together of doubled threads," with skilful attention to direction and amount of twist at every stage.

For example, a 60's/6 cord sewing thread produced by first making three two-cords, and then twisting these three together to make the final six-cord would be much superior to a six-cord obtained all in one process by the twisting and doubling of six individual yarns together in one doubling operation. The cabling gives a more tractable, stronger, more supple, and better stitching effect than is obtainable in the single operation.

The so-called doubling wefts in single yarns are usually spun twist way, twist size of cop, but termed weft, because they have only weft, or less than weft turns per inch.

Snarls in Doubling Weft.

In doubling, anything which causes one of the component single yarns to be slacker than its companions in producing the doubled yarn must inevitably weaken the latter yarn. Snarls in the single yarn must either draw out somewhat in the doubled thread, and thus become slack, and not bear a fair proportion of the pull, or else the snarls must fasten and loop so as to form a thicker place in the thread. In glacé thread it is possible for the polishing to lay down the thickness and roughness, but the brushing may again raise the looped places. Although snarls are often formed in the yarn at the spinning machine, yet it is quite possible for them to result from defective winding and doubling. In the latter case the defect is more likely to occur when direct doubling from cops or ring bobbins is resorted to, partly owing to unwinding from different diameters of cones. In winding it may be there is an insufficient amount of drag on the yarn, or ballooning is too free, or the yarn comes from cops or bobbins at varying speeds, and snarls are caused.

Characteristics of Voile Yarns.

Even in 1913 voile fabrics or cloth were a good deal in demand, with the result of creating a considerable amount of business in voile yarns among many doubling and spinning firms. A distinctive feature of voile fabrics is thinness, combined with durability and extreme neatness, as distinct from ornamentation by fancy effects in colours and pattern. Frequently a good, thin, bare finish

is required in voile cloths, with the weave well defined and clear, and this effect is largely dependent upon the character of the yarn that is used. The opposite twisting is not recommended for voile yarn. Woven one end per dent to enhance the clear effect.

It is quite common to utilise a good combed yarn of 100's or finer, spun from Egyptian cotton, and regard must be had to the fact that a thin, clear finished yarn is required so that full twist turns may be put into the single yarn. It is a common practice to make this yarn into two-folds at the doubling frame, and in order to produce a very concentrated clear yarn it may be hard twisted, with the doubling twist put in the same way as the spinning twist. We have heard of cases in which the single twist has been put in the reverse way from the doubling twist in voile yarns, with the result of requiring an excessively high amount of doubling twist in order to obtain a sufficiently thin and clear two-fold. Since extreme thinness and clearness are required, without the cloth necessarily being possessed of cover, fulness and softness, the doubled yarn may be gassed to enhance the particular features we have explained. On account of both spinning and doubling twist being put in the same way, care is needed in handling two-fold voile yarns, so that curliness and the tendency to form snarls are not unduly developed. Many fancy voiles are woven.

Tyre Yarns and Fabrics.

The boom yarns of 1919-20, and the desire to avoid the tremendously high prices maintained over a limited period for the high-class yarns mostly required for automobile tyres, led to the greater or less use of much lower qualities.

Tyres may be made by combining cotton yarns or fabrics, wire, and rubber. Rubber may be forced in and through the tyre cloth, and may also be applied to the outside of the fabric, to separate the component parts so that friction may be reduced to a minimum when the tyre is subjected to the tremendous wearing effects of road travel. Rubber may form the thick part making up the side walls, tread, and cushion.

In some cases cotton in yarn or fabric makes up to possibly 30 per cent. of the tyre weight, giving support and strength to the rubber. Wire helps where the tyre comes in contact with the wheel.

Builder and breaker fabrics may enter into a tyre, the first designed to give strength and firmness to the tyre, and the latter being made more open in order to absorb more rubber and give a better cushion effect. Tyre fabric may be run through calender rollers and impregnated with a rubber coating.

The fabric tyre may contain 32 ends per inch and 23 picks per

inch, 11/23's yarn in both warp and weft, 17¼ ounces per yard from the loom.

The other or second part of the total composition, or what is known as the "cord" tyre, is of a different character, and could scarcely be called a cloth.

The warp threads pass through the loom in the usual side by side order, but almost the fewest possible weft picks are inserted, with the simple object of just keeping the warp threads every way in correct order, succeeding picks being possibly so far apart as only to give 2 to 4 picks per inch, to hold together warp threads 22 to 23 per inch, the weft being also thick, strong material, possibly 5/23's. It will be understood that all kinds of experiments have been made in order to obtain the best possible motor car tyres at something like a reasonable cost, and the general opinion has been that cotton is easily the best medium. Good American of the more ordinary varieties, long staple American, Egyptian and Sea Islands, carded and combed yarns have been tested. The best motor car tyres now consume a very large proportion of the total annual crop of Sea Islands, good Egyptian, and long staple Arizona cotton. What may be termed second-best tyres consume a large amount of second-best cotton, since motor cars are found in tremendous and increasing numbers almost all over the civilised world.

The tyres of motor cars supply almost the latest and greatest example of the ever-increasing uses for cotton yarns and cotton fabrics. Cotton combing ought to be fostered by this vast tyre business.

Mercerising, schreinering, and sericising have previously furnished examples of extended developments in the use of cotton productions.

No doubt research and experiment will proceed still further in determining the values in motor tyres, of combed versus carded yarns, different sorts of raw cotton, proportions of twist in single and double yarns, manner of twisting and doubling.

Special Effects in Doubled Cotton Yarns.

Sewings.—Occasionally two-cord sewings are made, but more often three, four, or six-cord sewings.

Two-cord sewings are doubled weft way from either mule or frame single twist way yarns. The same with three-cord sewings. The doubled product of 3/30's equals in counts 2/20's and requires equal twist per inch.

Three-cord sewings are possible all the way from 120's/3 to 10's 3, but counts as high as 3/100's represent perhaps the highest qualities from super combed singles.

Both carded and combed single yarns are used for sewings, but uniformity and freedom from defects are vitally important. Either mule or ring-frame single yarn may be used, but ring yarn appears to increase in use for sewings.

Single yarn intended for sewings may be well conditioned in order to obtain good uniform winding.

Strength, smoothness, and elasticity in sewing thread are extremely desirable for either hand stitching or use in a sewing machine.

The thread may be reeled into hanks or made into warps for bleaching and dyeing and may afterwards be polished, although unpolished thread is used to some extent and is known as "soft finish."

Both hank polishing and warp polishing are in use.

Venetians.—Crepe-de-chine, voiles, and Venetians, are examples of light, fancy, fine cotton cloths produced in such districts as Colne, Bolton, and Nelson.

A Venetian thread may take, for example, an ordinary 80's single combed Egyptian yarn, doubled into a two-fold with opposite twist. For the purposes of uniform drag, some prefer the preliminary winding to be done on a bobbin winder rather than a cheese winder. Bolton yarns are much in favour for such goods as mentioned in this paragraph.

A good two-cord yarn is essential, and the foundation rests in the use of a good single.

On the ring doubler a comparatively heavy traveller is advisable; well-kept spindle bands. The expression rollers may run preferably inwards—though not indispensably so—and if the yarn passes first over the top roller, and lastly under the bottom one, there is little danger of threads running off the top roller ends.

Cut Rollers.—For some years it has been the custom to make small cuts or nicks in the edges of the top rollers, in order to help automatically in picking up the run-off threads when the frame is re-started. This running-off the top rollers when a frame is stopped has at times been very troublesome, besides incurring a danger of rusting or greasing the yarn. We may use wet doubling for Venetians, and possibly add a little conditioning solution in the water trough.

After doubling the yarn may be cleared upon bottle bobbins, gassed upon small cheeses, re-wound (and perhaps conditioned) upon warper's bobbins, and finally made into beams for use as warps.

Apart from the troubles due to threads running-off the top roller edges when a frame is stopped, many people prefer the yarn to come over the top of the rollers rather than from the middle or the bottom; and this is true for several kinds of doubled yarns.

Nettings.

Nettings represent a large field for doubled cotton yarns, and are more usually produced on the "P.P.G." and "Fin" methods to obtain the required strength and balance.

Care and skill required in the wet doubling and in the drying processes. Often the English system of wet doubling is adopted but not necessarily, and preferably the yarn is taken under the bottom roller, between the two and off the top roller, on the so-called Stockport system. Chiefly for nettings we use American cotton, wet doubled in both P.P.G. and Fin, cabled twist way, twist way, weft way.

When doubled yarns are required for special objects, such as covering of wires, hose-pipe covers, special sewings or special nettings, the special doubling conditions should be stated with the order.

After wet doubling there is danger of mildewing if the yarn is left too long on the bobbins, especially if certain ingredients are used in the water trough.

Wet doubled yarn may be reeled and the hanks hung up in a steam-heated drying-room, but this system wants only limited application or the yarn will become crimpy and intractable. It is possible for 100 lb. of wet doubled nettings to loose a dozen or more pounds or so in an ordinary drying chamber, and yet remain in a normal working condition for later treatment.

Fish nets represent a very heavy strong resultant and as an example we might take 32's/5 with twist = $\sqrt{\text{doubled}}$ counts × 5 in the P.P.G. and then five of these doubled together to make twenty-five cord in the finishing, and using the high twist constant of $\sqrt{\text{counts}}$ doubled × 10.

In every case of twist constants referred to in this treatise we take the square root of doubled counts.

Fish nets are often best produced on the flyer doubling frame.

Referring now to nettings, these are very suitably made from American cotton. Single yarn may be spun twist way but rather less than full twist. Net screens, net bags, fishing nets represent some uses of this doubled product. Anything usually from six-cord to twenty-seven-cord.

The high doublings usually require two doubling processes, P.P.G. and Fin, or preparing and finishing.

Wet doubling is preferable for fishing nets both in the P.P.G. and the Fin, twist way in single, twist way in P.P.G., weft way in finishing.

For twenty-seven-cord there may be made a nine-fold in P.P.G., and then three of these put together for the finishing.

$\sqrt{\text{counts}}$ doubled × 4·5 for the P.P.G., but the finishing twist constant somewhat lower to maintain suppleness in final product.

Voile Yarns.

In weaving mills producing light fancy goods, voile yarns were in tremendous demand in the few years preceding 1921. This demand was very good for Bolton spinnings.

The neat, thin, clear, light blouse cloths obtained from these yarns, combined with their wearing powers, immense range of patterns easily producible, and extreme suitability of Egyptian yarns for these yarns, all helped to maintain this class of business in general favour.

There are standard voiles and "mock" voiles. A genuine "voile" thread is a hard, thin, wiry two-fold, obtained from doubling together two good single combed yarns the same way as the spinning twist. Counts range mostly about 80's/2 to 100's/2, but as low as 60's/2 is reached. The "mock" voile may be produced by excessive twisting and special treatment of, for example, a single 50's to supersede a 100's/2.

Mock voile may be produced either on a mule or ring-frame, and if on the ring-frame yarn contraction due to excessive twist will be naturally allowed for by increased traveller revolutions, while on the mule the front rollers must deliver cotton more quickly than the carriage speed to allow for 50's single yarn being spun with extraordinary twist per inch. Mock voile may be either a combed or a carded yarn, say 40 to 44 turns.

Double Spun Single Yarn consists in producing a very hard twisted single by putting the twist in at twice—once on a spinning machine, and a second time at a doubling frame, both weft way. Mock voile consists in producing a very hard twisted single by giving all the twist at the spinning machine at one operation. In mock voile the carriage speed will be restricted to get the required twist per inch.

The excessive twist per inch in voile yarns render them very curly, snarly, and difficult to handle in such operations as winding, warping, and gassing unless special care is taken in the tension or drag arrangements. Voile yarns are used both plain and gassed, both as weft and as warp; and it is possible to get a very large number of ends in one warp. Bolton single yarns have at times been in great demand for voiles, both in the true voile and in the "mock" voile. A true voile may be 100's/2-fold. A mock voile 50's single with 40 to 44 turns per inch, roller delivery $3\frac{1}{2}$ to $4\frac{1}{2}$ inches greater per stretch than the travel of carriage.

Correct conditioning at the correct point of working is of great value in dealing with special lines, such as extra hard twist yarns, double spun yarns, and mock voile yarns.

Embroidery.

Embroidery yarn is usually rather softly twisted and sometimes of a rather heavy nature, coarse in the counts, although sometimes fine. Two-fold and three-fold embroideries are often required. A two-fold single weft from combed Egyptian cotton will give a good product; doubled twist way so as to give a smooth, pliable non-curly effect. The three-fold may take as low a twist constant as $2\frac{1}{2} \times \sqrt{\text{counts}}$ doubled, but the two-fold may require up to 3 as a multiplier.

For better sorts of embroidery either six or eight-ply may be produced on the cabling system.

The eight-ply may be a very superior product based on a 74's single Egyptian weft with 20 to 22 per cent. of short fibre extracted in combing, and 6 per cent. of fibre burned off in gassing so as to represent a final 80's single after first doubling. Weft way single, weft way first wet doubling, gassing, twist way finishing doubling, soft twisted each time.

For a six-ply take 38's single combed weft, make into two-ply as preparing wet doubling, weft way, now clear upon bottle bobbins, and gas up to 2/40's. Finally produce six-cord twist way, low twist per inch.

Fabric Gloves.

Yarns for fabric gloves may be 80's combed single. Doubled into two-folds these yarns make excellent, durable fabric for such purposes as fabric gloves, being good to look at, good to handle, easily adapted and fitted to the hand, and comfortable to wear.

There are many English makers, but the chief centre has been Saxony, although from Bolton yarns; raw cotton from Egypt, yarns spun in Bolton, Saxony often importing such yarns free from duty, and then sending large quantities of the gloves back to England. At the beginning of August, 1922, a British tax of $33\frac{1}{3}$ per cent. was imposed on German fabric gloves at the instance of English glove-makers, but against the protests of Lancashire spinners.

Various Products.

Embroidery cabled may be weft way, weft way, twist way; crochet yarns twist way, weft way, twist way; sewings cabled may be twist way, twist way, weft way. Embroidery threads are usually from good combed single yarns. Embroidery yarns are sometimes produced with special effects on a fancy doubling frame. Sewings depend more upon a plain, supple, tractable strong resultant, and knittings upon a plain, soft resultant. Combing,

gassing, and even mercerising, are often utilised in producing best embroidery threads and help in the use of cotton yarns instead of silk or linen. Low doubling spindle speeds are needed for knittings and embroideries.

It is well known that rovings direct from the jack frame can be made very suitable for certain goods requiring high-class lustre effects.

Indeed, during the war, some spinning firms developed a big and lucrative trade in roving frame yarns, and kept their mules stopped, partly owing to the fact that the minders and side piecers required for mule spinning were so many of them in khaki.

Some typical coarse embroidery may be obtained from 8's or 10's roving, from combed cotton, first re-twisted same way on the flyer doubler in the P.P.G. process. Dyeing in bright colours is often required for embroidery threads, the single roving counts from 1's up to 10's often made into two-folds and three-folds.

Finer single counts for the finest and thinnest sorts of embroidery.

Coarse Cordonets resemble coarse counts embroidery yarns in possibly using single yarns 1's to 10's from the roving frame.

The twist, however, is $1\frac{1}{2}$ to 2 times as much as for embroidery, producing a lustrous, firm two-fold. Twist constant in double spinning and again in finishing $\sqrt{\text{counts}} \times$ about 5. Double gassed, with strong flame to obtain maximum effects, hard, yet lustrous finish.

The "Plauen" embroidery trade is usually rather an extensive one, although some of the embroidery machinery of Germany was sold or scrapped in 1920.

Embroidery v. *Knitting Cotton Yarns.*

These may be produced on an ordinary doubler without using any "novelty" mechanisms. Two or more spun threads are required for producing embroidery yarns at the doubler. If spun on the "fancy" doubler the threads would pass through the front line of rollers only. Both embroidery and knitting yarns are soft twisted with few turns per inch, of either two or more folds, of either medium or coarse counts; these yarns are similar in character. The required soft, woolly character required in knittings is best developed by dry doubling, by light application of "drag." Twist about $2\frac{1}{2} \times \sqrt{\text{counts}}$ doubled. Taking a 20's single, for example, the twists per inch might be about $13\frac{1}{2}$ for two-cord, $8\frac{1}{2}$ for three-cord, 7 for four-cord.

Good doubling winding and freedom from bunch knots are very desirable. Knitting yarns are sometimes lubricated.

Knittings are very often required for utility, whereas embroidery yarns are more for embellishing or ornamenting purposes, and, therefore, often take finer and better qualities of yarn, often gassed and mercerised, and from the better sorts of cotton.

In a certain typical rather thick embroidery yarn, there were two threads of different colours, twisted together at the doubling frame with about 8 turns per inch. Afterwards this doubled product was re-doubled with a fine binding thread, again with 8 turns per inch, but the spindles running the reverse direction of the first doubling.

Knittings and mendings are required to be soft and nice-feeling, so these yarns are usually soft spun and soft doubled. Moderate qualities more usually from American cotton, better qualities from Egyptian, either mule or ring-frame singles, mostly frame doubled.

For hosiery purposes counts below 9's are sometimes more profitably and nicely spun on the roving frame, but can be mule spun if required.

Knittings and mendings should be ungassed and dry doubled, because softness and fulness are required as distinct from the hardening effect of gassing, and the solidifying effect of wet doubling.

Sewing Thread.

A firm, solid, strong, smooth, round thread is required for cotton sewing thread, and can only be obtained from spinning single cotton yarns finer, and then doubling more or less of the single threads together. The best cotton, the best mill treatment, the utmost twist per inch, cannot produce a good sewing cotton in single yarns. Single throw 4-fold is not unknown.

For two or three-fold one twisting operation subsequent to spinning may be sufficient for thread. For the selvedges of sponge cloths or other coarse goods, sewn upon an overlock power machine, 2-fold American yarns may be used.

For higher doublings such as four-fold and six-fold, two twisting operations are usually necessary subsequent to spinning.

Four-fold or six-fold produced on the cabling system may use twist way single yarn, make two folds by again twisting twist way, then put two or three of these together and thus produce the four or six-fold thread by twisting weft way.

This method of producing thread on the cabling system gives a sewing thread more pliable, more tractable and usable, stronger, smoother, better looking, and capable of giving a better stitch than if produced at one twisting and doubling operation. Wet doubling is customary and helps in the desired objects.

(1) Spinning, (2) doubler winding into two-folds, (3) ring twist-

ing, (4) winding by one or other method as specified later, (5) final twisting.

Afterwards come operations required for giving the proper colour and finish to the thread, and for making-up for the markets.

Four-fold or six-fold sewing thread produced on the treble twisting system is the best :—

Spinning twist way.
P.P.G. ,, ,,
Finishing weft ,,

After spinning, subsequent procedure may follow on some such lines as below stated.

1. Two ends are wound together on one or another type of winding frame, fitted with automatic stop-motion whose use prevents corkscrewed and single yarns. This process also winds the yarn upon cheeses or bobbins each containing a long length of well-produced thread, which greatly reduces the work and improves the quality and quantity of work done at the next process.

2. Threads produced as per No. 1 are twisted at one or another kind of twisting frame—nearly always the ring doubler for sewing cottons.

3. (*a*) It is now possible for the twisted two-folds to be taken to the stop-motion doubler winding frame and two or three ends wound together (as per No. 1) ready again for the twisting machine.

(*b*) An alternative and favoured method has been to use the vertical spindle winding frame—termed in this case a clearing frame—and to wind each two-fold separately upon double flanged bobbins. This method favours the removal of any bad knots or other defects in the yarn and cleans it, by passing through narrow adjustable clearing slits and over flannel-covered drag-boards, or other tension device. The two-fold yarn is quite strong and not very susceptible to breakage either at the clearing frame or the finishing doubler.

4. The next process is the second doubling twisting—often on the ring doubler, sometimes the flyer doubler, but very rarely the twiner. The latter does not lend itself either to the round solid thread or the number of doublings required for good sewing cotton. For four-cord two flanged bobbins, and for six-cord three flanged two-fold bobbins are placed in the creel for each twisting spindle, and subjected to side unwinding.

5. In the conversion of single spun yarn into four or six-cord, winding frames play an important part.

The finally twisted thread now often requires to be treated by bleaching and dyeing processes, and finally making up for the different markets.

The first of these stages may be winding the twisted and

doubled thread from the doubling frame bobbins upon flanged warpers' bobbins, probably using the vertical spindle winder. From this winding frame stage there are alternative methods of treatment, a good deal dependent upon the colour, appearance, and final make-up of the thread.

6. After winding the doubled and twisted thread upon warpers' bobbins, the required number of these bobbins—120 to 360—are placed in a warper's creel and made into beam or chain warps as desired. Proper attention must be given to leasing or dividing of the threads, to facilitate subsequent operations and prevent entanglement in bleaching, dyeing, or other operation.

Direct polishing from these warpers' bobbins has been sometimes done. Methods of warping are explained elsewhere.

Thread may be polished either in the warp or hank form, and when it is for hank polishing the thread may be reeled on strongly built reels, directly from the doubling frame bobbins.

Polishing.—(*a*) Hank polishing is done on a comparatively simple machine, but is somewhat of a speciality. The hanks of yarn are passed round two suitably sustained and driven rollers, the lower one being adjustable by rack and pinion so as to correctly tension the yarn. Adjustments are provided for placing the hanks at the correct distance from the polishing brushes. The cylindrical revolving brushes operate very quickly on the yarn, polishing mixture may be used, and a polishing effect obtained almost on the same root principle as in polishing boots in any household

Previously—at any rate in some cases—the yarn hanks may have been linked together to form a long chain, and in this way passed through the bleaching processes.

(*b*) The warp polishing machine is on a larger style. Assuming the yarn has been placed in the form of beam warps. The beams of four or six-cord thread are placed in a suitable creel in the polishing machine. The threads in open extended line or sheet form are conducted through a trough containing liquid polishing mixture.

Emerging from the trough the excess liquid may be squeezed out of the yarn by one or more pairs of adequately weighted rollers.

Proceeding through the machine the sheet of threads is now treated by cylindrical revolving brushes to whatever extent may be required to give the full polishing effect.

Opinions differ as to the ingredients of the polishing liquid, and the manner and amount of brush polishing. There may be two or three brushes in operation. Chain warps may be treated in a much similar manner. If required, bleaching and dyeing may precede polishing.

Bleaching and Dyeing naturally involve several extra operations such as may be only just mentioned here.

(*a*) For bleaching, linked chains may be packed into a kier and boiled for some time in an alkaline solution.

(*b*) The washed yarn may now be passed through a bleaching cistern and subjected to the chlorine or bleaching mixture, and sulphuric acid for souring. There may be

(*c*) Blueing and washing, extraction from the yarn on as much as possible for the liquor by hydro-extractors, and then drying of the yarn. Hot-air drying, or steam-heated cylinders, for drying, have largely superseded simple exposure to pure, clean fresh air.

Chaining.—Instead of beaming into a sheet of threads, the four or six-cord sewing threads may be formed into chain warps which may be linked together into suitable receptacles ready for bleaching or dyeing.

Dyeing to specific colours complicates the processes even more than does only bleaching.

Especially is this true when thread must be dyed in light bright colours which involve extra trouble in bleaching. For black or other dark colours the yarn may be washed without bleaching. Dyeing is not in the scope of this treatise.

Glazed and Unglazed Thread.—It is not all thread that is polished, brushed, and glazed into *glacé* thread. There is a large amount of unglazed or soft thread receiving much less treatment, and soon finds its way from the doubling frame bobbin into market form.

Market Forms.—Winding frames of one sort or another may be again utilised in transferring finished thread from hank, chain, sheet or other form, into spools, or other style for the market.

(*a*) The most common household form for sewing thread is the bobbin or spool of varying size according to price and style. These are everywhere obtainable in many colours.

The winding or spooling machines contain some principles of resemblance and others differing from the types used for larger bobbins. Quite a short machine with few spindles may be used for small package winding. One side may be independent of the other in order to produce packages of different widths and diameters, but for large business such sub-division may not be necessary.

Measuring motions may be used to ensure exact lengths on each bobbin—a very important matter in marketing.

The loose hanks or skeins of thread appear less prevalent in households than formerly.

Small bobbins or spools, skeins or hanks, and balls of cotton, are all common household forms.

Spools are obtainable by some kind of winding frame.

Skeins represent definite reeling lengths.

Balls are formed by other special machines, which may contain

arrangements for controlling the length of yarn on each ball, for making a firm crossing of the yarn into ball form, without needing a wood bobbin, for ticketing the balls, for controlling the size and shape of the ball and varying the crossing.

The ball form is a household favourite for crocheting cotton.

Thread Spools.—Sometimes there is a large amount of wood for a short length of yarn or thread. Spools of sewing thread usually contain tickets more or less purporting to indicate the folds, the counts, and the length. The tyro often finds them difficult to interpret. Spools may be numbered from 10 to 60 or higher, to indicate the counts of single yarn used.

The ticket numbers may indicate the counts or number of hanks required per pound.

Sewing cotton of 6/36's may pull a thread strength test equal to $9\frac{1}{4}$ lb., 6/60's = $6\frac{1}{2}$ lb., 6/100's = $4\frac{1}{2}$ lb., each single thread test.

Polishing Materials.—Paraffin wax, oil-cake wax, Indian corn starch, white soap, oil soap, castor oil are possible ingredients of polishing mixtures.

A polish for white thread may be composed as follows :—

Add 1 lb. of oil soap well cut up to about 20 gallons of water heated to 170 to 180° F., well stirred and made into proper soap water. Take possibly about 8 lb. starch well mixed with cold water and then put to the soap water. Add $1\frac{1}{4}$ lb. of paraffin wax and $\frac{1}{4}$ lb. of castor oil.

Lisle Threads.

"Lille" is celebrated as the "Bolton" of France, the chief continental centre for fine cotton spinning, and the author has had many cotton spinning students from that important centre. "Lisle" is a well-known name for certain doubled thread, and it has been suggested that Lisle was the original name for Lille, and hence the name applied to this doubled yarn, noted for its hard, neat, wiry nature, and long used in French textile districts, for such goods as lace and gloves, both from cotton and linen.

A Lisle cotton thread may be made from full twist singles, and rather hard twisted in doubling. Mostly inside the usual range of lace yarns 50's/2 up to 100's/2 or finer, and gassed rather better than some lace yarns, possibly by the modern vertical burners, or even double gassed in the ordinary small bowl gassing frame.

The twisting position of Lisle two-folds will be understood from the following statement :—

Two-folds	ordinary or usual twist		$\sqrt{\text{counts doubled}}$	$\times 4$
,,	Lisle twist . .	,,	,,	$\times 4\frac{1}{2}$
,,	hard . . .	,,	,,	$\times 5$
,,	extra hard . .	,,	,,	$\times 5\frac{1}{2}$

A Chemnitz report, January, 1921, says: "Fine Lisles, more especially in mercerised, are now in good demand, whereas lower qualities are slower in sale. Fine Lisle gloves, for which there used to be a good demand in pre-war days, and in the manufacture of which fine Sea Islands two-folds are used, are now too expensive to find purchasers."

Lace Purposes.

The lace trade stands out as a distinctive and prominent field for doubled yarns, just as do also the hosiery, double warp, and sewing thread businesses, although the lace trade mostly wants two-folds.

Doubled yarns for the lace trade are mostly gassed, and the lace trade of the Continent, Japan, and Great Britain finds more work for cotton gassing than any other special line.

Dr. Ure in his writings first published in 1836, referred a good deal to the lace or bobbin-net trades, and also to the process of cotton gassing.

Lace articles are generally associated with quality, pressing into use either silk, linen or cotton. A good deal of Bolton cotton yarn finds its way to Nottingham for the purposes of lace making, leaving Bolton both in the single and two-fold conditions. Flyer doubling is still in favour with some doublers for lace threads, the solid round character of the threads and high qualities perhaps helping in this. Lace yarns are required all the way, from 40's/2-fold to 220's/2-fold or finer, in cotton.

"Mock" lace yarn of single 90's is occasionally wanted to be used instead of 180's/2, the spinning twist for the 90's being the same way as the doubling twist for the 180's/2. Mostly gassed.

Lace yarns are not only required to be very compact for the character of the goods, but also because such a limited length of yarn can be got on one of the small brass bobbins used in the process. Said bobbins simply consisting of two brass discs with a space between them to hold just one thread wrapped round itself between the discs. There are hand-made laces and machine made. Lace curtains are of widely differing qualities, and consume correspondingly different counts and qualities of yarn. While good combed Egyptian or Sea Islands are required for high class lace threads, carded Egyptian do very well for some medium ranges and American may serve for the lower kinds.

For the very finest lace yarns, a particularly limited amount of hand-mule yarn up to about 400's, spun at about one mill in England and another one in France, has been in occasional demand. As witnessed by the author, the single yarn was spun on the box organ hand mule, counts 420's treble combed, best Sea Islands cotton, three weeks to spin a set of cops, at Oliver's in Bollington.

The limited productions of the flyer doubler have led to the use of ring doublers for much of the lower counts of yarn. The twiner also has a good grip of some portion of this kind of trade, and a good twiner minder will maintain a low proportion of corkscrewed and single yarn, as will also a good flyer doubler, even if the doubling winding frame is not used.

The ring doubler has a vogue for counts 60's/2 down to 20's/2,

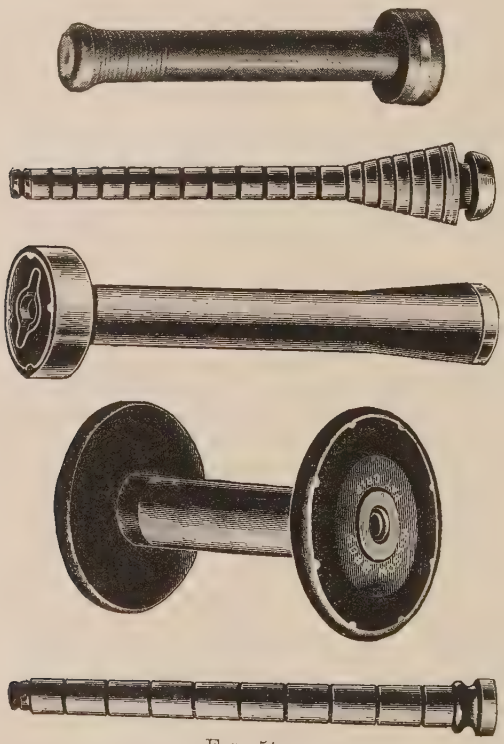

Fig. 51.

the threads passing under bottom roller, between the two rollers, and from top roller down to spindle; rings $1\frac{3}{4}$ to 2 inches diameter.

In the flyer doubling there is usually a band passing half round the spindles in order to apply sufficient drag, the band being easily tightened. Plenty of drag is essential for best results in roundness, strength, and uniformity of thread.

The gassing of lace yarns is done at different stages, sometimes in the single yarn, sometimes after the doubling. More gassing

effect is obtainable in the single yarn, but the later gassing allows of clearing upon large bottle-shaped bobbins before gassing, and the best system is probably as below stated for average results: Spinning of single yarn, doubling winding, ring or flyer doubling, clearing upon bottle-shaped bobbins, gassing upon small tubes,

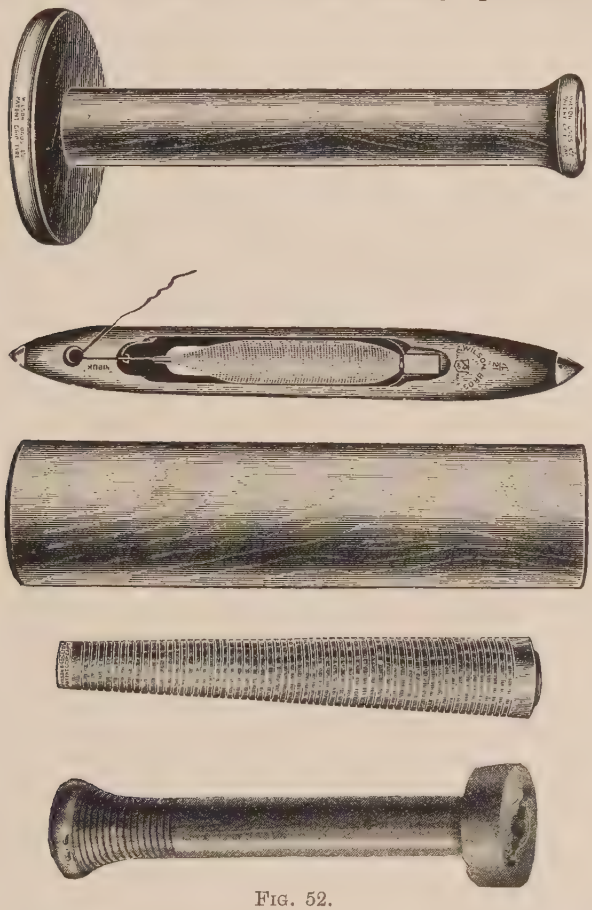

Fig. 52.

reeling into hanks, preparing, making-up for transit. Wet doubling is frequently in use for lace two-folds, although they are afterwards gassed.

In some cases a kind of double twisting effect is obtained after the principle of double spinning of single yarns.

Suppose, for example, a 90's/2 requires 40 turns per inch, some advantage in resultant strength may be obtained if the thread is twisted at twice, inserting, perhaps, 18 twists first time and then twisting up to the 40 per inch at a second attempt and with a heavier traveller. These two twistings are in addition to the spinning twist.

Figs. 51 and 52 illustrate typical bobbins for ring spinning, doubling and winding frames as made by Wilson Bros., of Liverpool. A shuttle of their make is also included. These are typical of other productions by the same firm, including hand-threading shuttles.

Air-Craft Fabrics.

The great war caused enormous interest to be directed to the production of air-craft fabrics. Many experiments were carried out, many results obtained, and even in this branch cotton came out very well in comparison with other textile fibres such as silk, wool, and flax.

An inspection school for air-craft fabrics was established in Bolton during the war, and a score or so of lady inspectors attended Bolton Textile School for instruction relating to this work, from the present author.

Fabrics much used for air-crafts have been silk, linen, and cotton.

Taking a cloth of each type weighing 3 ounces per yard square, the strengths per inch have been found to be

Silk	106 lb.
Linen	67 ,,
Cotton	56 ,,

"Stretch" of each type before breaking has been: silk, 28 per cent., cotton, 16 per cent., linen, 11 per cent.

Taking first cloth for balloon fabric, it has been found by practice that extension or stretch of the silk is a positive disadvantage, as it makes it impossible to control the shape of the envelope.

In the case of linen it is found that the great natural variation in the fibres in respect to length and evenness, make it difficult to produce a cloth anything like as even for the purpose as silk or cotton, although in respect of resistance to tearing, the linen is easily the best of the three.

Passing now to the suitability of each type in respect to the "proofing," it has also been established by practice that the proofing suitable for this purpose is rubber proofing, as the principal requirements which this proofing must fulfil are:—

1. The ability to contain hydrogen gas.
2. The ability to resist deterioration in strength when exposed

to weather. In respect of this system of proofing, it has been satisfactorily established that :—

1. Silk cannot withstand the temperature necessary for vulcanisation.

2. The open cloth of linen fabric causes a very heavy proofing to be necessary, and in addition, linen rots quickly after proofing.

Cotton can be proofed perfectly, and with a good yarn in the cloth, without deterioration. Circumstances thus make it advisable to use cotton for balloon cloth.

The deterioration in strength of plain fabrics due to exposure to atmosphere is remarkable, and has been determined as below :—

Pure net silk	80 per cent.
Finest quality linen	45 ,, ,,
,, ,, cotton	25 ,, ,,

Cotton cloths used have been :—

1. For airships of the largest type, a fine cotton cloth weighing 3 ounces per square yard, and breaking at a strength of about 58 lb. per inch both in the direction of the warp and of the weft.

2. A finer fabric for airships of the smaller type. This fabric weighs $2\frac{1}{2}$ ounces per square yard, and breaks at about 45 lb. per inch in both directions.

3. Aeroplanes of the bi-plane type use a strong cotton fabric of from $2\frac{1}{2}$ to 4 ounces per square yard, and breaking at from 40 to 60 lb. per inch in both directions; 60's/2 cotton has been much used for aeroplane cloth.

The yarns from which these cloths are made are spun from the very best Sea Islands and Egyptian cottons. The cotton is combed with great thoroughness, and as much as 27 per cent. of waste may be extracted to eliminate short fibre.

The counts may range from 30's to 70's, and are the same counts in the same cloth both for warp and weft, but occasionally one or two hanks finer may be put in for the weft.

The yarn used both for warp and weft is the same in twist, and must pull the same strength, the only difference being that one is large cop for warping, and the other is spun pin cop for the shuttle. This is necessary, as the cloth must be as strong in the direction of the weft as the warp.

The yarn must be spun and twisted to give a hard compact thread, usually full twist turns being inserted. This is necessary not only from the point of view of the strength, but also to obtain the necessary concentration to enable the thread to resist the great heat of the vulcanising process.

The yarns must be as even in count and diameter as possible in order to make up, into a close compact cloth, as it is on the degree

of compactness in the cloth that the weight of proofing depends, as well as the efficiency of the proofing itself. Thus, an uneven yarn will of necessity give a less compact cloth which will increase the weight of the proofing and thus lead to its premature breakdown.

Yarns for Motor Tyre Cloth.

Yarns for motor and bicycle tyres vary a great deal in quality, and although for the best results good Sea Islands and best Egyptian singles, well combed, give the best results, yet carded yarns are sometimes utilised, and the high yarn prices of 1920 fostered this tendency.

Strength and durability are required in tyre yarns, rather than fineness and lustre. The single yarns mostly range in counts for motor tyres, from 22's to 34's, always doubled many-folds, and a well-known line consists of 23's or 24's single yarn, doubled up to twelve or thirteen-fold.

Uniformity in tension at all stages, freedom from singles, well-kept spindle bands in both spinning and doubling, are required for motor tyre yarns.

Ring yarns are very suitable in the singles. Immense business has resulted in good cotton spinning and doubling mills, owing to the enormous modern development in the use of motor vehicles for both pleasure and business; and especially in America this business boomed in the war years and the years immediately subsequent, both tyres and tyre yarns being imported into Great Britain. The motor tyre business has come to stay, motor tyre yarns should suit the spinning, doubling, and weaving mills of Great Britain, and our mill masters and managers will do well to note this.

Strong sewing threads, crocheting yarns, and heald yarns, are usually cabled, but motor tyre yarn doubling may be done all in one doubling operation.

Although cheaper yarns have been used in some cases, yet the great wear and tear that tyres are subject to is patent to every one, and tyre yarns should be distinguished for strength, uniformity, durability, and elasticity. The best mills producing tyre yarns subject their products to frequent testing and examination, and take great pains to secure the best results. Purchasers of tyre yarns usually insist on specified minimum strength tests.

The fact that tyre cloth is more or less combined with rubber adds to the need for tyre yarn being free from any impurities likely to damage the rubber.

Bicycle tyres of lower qualities may be made from carded yarns and as low as four-folds in doubling.

When the Safeguarding of Industries Act was introduced in the summer of 1922, some Lancashire spinners producing yarn for British tyres, favoured the imposition of a duty upon foreign tyres to stop these from being dumped in England.

The doubling winding frame is utilised in winding the required number of single threads together, and a great factor is to use slow speeds, few drums per operative, and maintain equal tension on each individual component yarn, as a basis for the best doubled thread from the doubling frame.

The slow traverse drum winder on flanged bobbins is often preferred for motor tyre yarns.

A mill manager informed the writer, there was often a good demand for 23's ring yarn for motor tyres, the doublers making this into 11-fold or 13-fold with only moderate twisting.

Both ring and flyer doubling frames are in use for motor tyre yarns, and the high number of the ply requires low spindle speeds —possibly 3,000 to 3,500 r.p.m.—gauges of 4 to 5 inches, lifts of $4\frac{1}{2}$ to 6 inches, and plenty of bobbin drag during doubling. It has been stated that 6-inch gauge is sometimes used in America for tyre yarn twisting.

Clearer winding, warping or else pirn winding may succeed doubling.

The use of a Balfe's or other piecing machine may help in piecing the broken many-ply yarns without making bunch knots.

Double Spun Single Yarn.

Sometimes there has been a fair demand for double spun yarns, i.e. single yarns, which have been twisted twice over, or at two different machines. As the twist is the same way both times the net effect is a very much harder twisted yarn than is usually required.

An underlying principle of this yarn has been the production of a cheaper yarn than two-folds of equal final counts, this being largely for the lace trade.

For this "double spun" or double twisted yarn the process may be as follows :—

1. Mule spinning weft way.
2. Winding upon flanged bobbins or else upon cheeses.
3. Second twisting on the doubling machine, weft way. Using a wet doubler to increase the concentrated effect.
4. Clearing.
5. Gassing.
6. Reeling.
7. Preparing.

A strong, thin, concentrated yarn is obtained which sufficiently resembles a two-cord yarn, to serve as a cheaper substitute in many lace goods.

The full effect is not obtainable in single yarns, although it is approached still more nearly in some cases by clearing before and after doubling.

2/120's to 2/180's have long been standards for really good fine lace goods, the single yarn being spun twist way and the doubler twist being weft way. Hence the reason for the double spun yarn being weft way for each twisting, to equal in counts the better class two-folds.

To spin, for example, a 160's single yarn and then double it into an 80's is much more costly than spinning an 80's forthwith.

The typical lace two-folds have single yarn twist way and the doubling weft way; whereas the typical voile two-fold has both spinning and doubling twist way. A "mock" voile has extreme twisting and all twist way in one operation. A "mock" lace or single double spun has twisting done at two operations both weft way.

For double spun yarns, either on the "mock voile" or "mock lace" principle it is customary to use double combed rovings at the spinning machine.

Gassing and preparing are not made easier in subsequently treating the yarn, by the double spun effect. The lowest qualities of imitation double spun may be obtained by hard twisting one operation at spinning machine, weft way of spindles, and this kind is much inferior to ordinary double-spun single yarn. In making real lace two-fold yarns the twist in the component singles is reduced in proportion to the doubling twists, and this gives a balance to the thread, not obtainable by double spinning, or spinning at twice, and much less by imitation double spinning in finishing the yarn by one twisting operation. Clearing and gassing of double-spun yarns may be done after either the first or the second twisting.

In double spinning each of the two twisting operations may take a twist constant of $\sqrt{\text{counts}} \times 2\frac{3}{4}$, this being subject to slight variation in either case according to judgment and experience; or 3 taken as first constant and $2\frac{1}{2}$ as second constant. Conditioning troughs used at the doubling frame, pure water if twisted after gassing, conditioned water if double twisted before gassing.

Doubling Contraction.—Twist shortens yarn in either the single or doubled state. Full twist may shorten about 3 per cent., low twist 2 per cent.

For a 100's/2 we may require 102's or 103's single in order to come out a true 50's doubled yarn.

Weft Way and Twist Way.

In single yarns "doubling weft" usually means twist size of cop, twist way of spindles, but only weft or less than weft turns per inch.

If spun "weft way" the term "reverse" doubling weft is sometimes applied to the single.

It is important to know that in spinning, "reverse" twist means weft way because three-fourths or more of all the cotton yarn that is spun is twisted twist way.

In doubling weft way is the more common, and therefore the term "reverse" way in doubling may mean twist way or just the opposite to the custom in dealing with single yarns.

Reverse way in single yarns means weft way.

Reverse way in doubled yarns means twist way, at any rate with very many doublers.

When doubling twist is added the same way as spinning it may be termed "positive" or + doubling, and – or negative doubling if spindles revolve opposite to spinning.

One doubling twist removes one twist from the single yarns when negatively doubled.

The author has been often challenged on this point, but it may be demonstrated by giving a reverse twist to two or three strands of spindle banding; in negatively doubling them together on a 12-inch hand tester for twist, leave only one component strand in the tester and compare its present twist with its original twist. Soft spun single yarns are more likely to retain lustre and a nice "feel" after doubling than are harder singler. In the period 1890-1896 the author conducted textile evening classes in such towns as Glossop, Hyde, Ashton-on-Tyne in which he was repeatedly challenged in regard to the effect of using weft way weft for the shuttle, or twist way weft in plain or twill cloths, American cotton, twist way warp, single yarns from single rovings.

Repeated investigation demonstrated that the weft way weft would give a better cover, a softer feel, and a fuller appearance than the twist way weft, but the latter give rather more strength. In several proved cases weft was more or less ignorantly or inadvertently used having the opposite twist to the customary weft, resulting in trouble with cut lookers, printers, bleachers, or other people dealing with the cloth.

The way in which the twists of the warp yarn cross those in the weft yarn has a good deal to do with these variations in cover, feel, and twilling effect.

In the same way, when doubled yarns—more usually two-folds—are used in producing cloth, the direction of twist in warp and weft is not a matter to be disregarded in seeking specific effects.

In making warps from single or doubled ring yarn test results are usually obtained by having the yarn to pull the bobbin and rabbeth spindle round in the creel of the winding frame, giving a good uniform yarn tension. This also leaves the twist unaffected by winding, and if unwinding from the nose one twist is added for each coil removed, and it is not possible as in cops of "Bump" yarn produced on the Chapon spinner or "Jumbo" winder, to unwind from the base of the cop or bobbin.

Winding on at mule cops, ring bobbins, winders, bobbins or cheeses, gives what may be termed "latent" twists which are afterwards developed if the yarn is unwound over the top end of the cop or bobbin, but not with side unwinding.

Doubling Twist Constants.

Below is a table of twist constants substantially as given by the author in his classes for twenty-five years or more, using well-known doubling expressions :—

1.	Usual or common standard	$\sqrt{\text{counts}}$	doubled	× 4.
2.	Medium twist	,,	,,	× 3·40.
3.	Soft	,,	,,	× 2·80.
4.	Extra soft (X soft)	,,	,,	× 2·20.
5.	Extra extra soft (XX soft)	,,	,,	× 1·80.
6.	Treble X soft (XXX soft)	,,	,,	× 1·52.
7.	XXXX soft	,,	,,	× 1·32.
8.	Hard twist	,,	,,	× 5·00.
9.	Extra hard	,,	,,	× 5·40.
10.	Extra, extra, hard twist or crepe	,,	,,	× $5\frac{1}{2}$ to $6\frac{1}{2}$.

These represent the more common twist standards and expressions, more especially applied to ring doubled yarns, but not necessarily so. Hereafter are quoted twist constants for flyers doubled threads.

Take, for example, 50's/2-fold and find twist per inch with each of above constants.

50's/2 = 25's resultant $\sqrt{25} = 5$.

1.	= 5 × 4	= 20 turns per inch in doubled thread.
2.	= 5 × 3·4	= 17·0 ,, ,, ,, ,, ,, ,,
3.	= 5 × 2·8	= 14·0 ,, ,, ,, ,, ,, ,,
4.	= 5 × 2·2	= 11·0 ,, ,, ,, ,, ,, ,,
5.	= 5 × 1·8	= 9·0 ,, ,, ,, ,, ,, ,,
6.	= 5 × 1·52	= 7·6 ,, ,, ,, ,, ,, ,,
7.	= 5 × 1·32	= 6·6 ,, ,, ,, ,, ,, ,,
8.	= 5 × 5·0	= 25·0 ,, ,, ,, ,, ,, ,,
9.	= 5 × 5·4	= 27·0 ,, ,, ,, ,, ,, ,,
10.	= 5 × 6·5	= 32·5 ,, ,, ,, ,, ,, ,,

Twist Per Inch Constants.

In the card-rooms and spinning-rooms the twist constants may be taken as below given :—

Fly-Frames.

Sea Islands cotton below 3-hank	$\sqrt[2]{\text{counts}}$	×	·56	=	twist per in.
,, ,, ,, above 3-hank	,,	×	·66	=	,, ,, ,,
Egyptian cotton below 3-hank	,,	×	·7	=	,, ,, ,,
,, ,, above 3-hank	,,	×	·75	=	,, ,, ,,
,, ,, ,, 9-hank	,,	×	1	=	,, ,, ,,
Ord. Amer. cotton below 3-hank	,,	×	1·06	=	,, ,, ,,
,, ,, ,, above 3-hank	,,	×	1·26	=	,, ,, ,,
Fair Indian cotton below 3-hank	,,	×	1·3	=	,, ,, ,,
,, ,, ,, above 3-hank	,,	×	1·45	=	,, ,, ,,
Mod. Indian cotton for all counts	,,	×	1·5 or 1·6	=	,, ,, ,,
Brazilian and Peruvian cotton for all counts	,,	×	1·25	=	,, ,, ,,

Other cottons twist as above table for which above cotton most resemble.

Mule and Ring Yarn Twist Constants.

Sea Islands cotton, mule yarn	$\sqrt[2]{\text{counts}}$	×	$2\frac{1}{4}$ to 3.
Egyptian cotton, mule and ring twist	,,	×	3·606.
,, ,, ,, weft	,,	×	3·183.
,, ,, doubling weft	,,	×	$2\frac{3}{4}$ to 3.
American cotton, mule twist	,,	×	3·75.
,, ,, ,, weft	,,	×	3·25.
,, ,, ring twist	,,	×	4.
,, ,, ,, weft	,,	×	3·6.
Extra hard twist yarn or crepe yarn	,,	×	$6\frac{1}{2}$ to $7\frac{1}{2}$.
Hard twist	,,	×	5.
Indian cotton, ring-frame twist	,,	×	4·5.
,, ,, mule weft	,,	×	3·75.

Analysis of Doubled Thread.

Probably more so in doubling than in spinning, a firm may be required to match samples, and the responsible person must subject the samples to analysis and examination.

Direction of twist in doubled yarn will be very apparent with an ordinary counting class or by untwisting with the fingers. Direction and amount of twist per inch may be readily ascertained by the use of the plain old-established 12-inch twist tester. Single thread strength testers may be needed.

If single yarns are skilfully extracted the direction and amount of twist in the singles may be near enough judged by the aid of a small twist tester fitted with a magnifying glass, and taking only 1-inch length of yarn at one time. General examination and observation always help materially in the analysis of doubled threads.

Direction and amount of twist in single yarns, in the preparing doubling, and in the finishing doubling; whether combed or carded cottons are used. Kind of cotton; whether gassed, plain, or polished, number of folds; wet or dry doubled; are essential factors to be ascertained in a full analysis of doubled threads. Coloured, grandrelle, and novelty threads present still other features. Strength testers are advisable in finding strength of single or doubled yarns.

It will be for the experienced doubler to say how best to arrange his spindle speeds, amount of drag, amount of wetting or conditioning, amount of clearing or gassing, and all the many details required for producing specific results from the single yarns given to him.

Analysis of Doubled Yarn.

It has long been possible to test the twist of a piece of doubled yarn in an accurate manner by means of twist testers of one kind or another, this being a much simpler matter than finding the twist accurately in a single yarn. The ordinary twist tester for doubled yarns may serve for any length of yarn up to 12 inches or so, and the sample of thread is secured between the fixed and rotating jaws of the machine. Assuming, for example, that 8 inches of yarn is placed in the machine and then the hand wheel is rotated until the twist is considered to be all out—a fact somewhat readily determined in doubled yarns by running a needle or pointer along the length of the yarn between the component threads. Assuming, for example, that 96 turns were registered on the dial then this would average 12 turns of twist per inch of doubled yarn. Some idea of the extension in the thread may be gathered by simple observation in any ordinary twist tester, but in some cases the end of the thread is held by a weight which moves through space as the thread lengthens, due to the untwisting.

(*b*) The counts of single yarn may be gathered in one or two ways, as, for example, if we first find the counts of doubled yarn to be 20's, and there are two ends doubled together, the counts of single yarn will equal $20 \times 2 = 40$, or, say, possible 41's or 42's when allowance is made for contraction due to doubling twist. It may also be possible to unwrap or unpick a short length of the single thread out of the doubled thread, and then twist the counts

by means of one of the small testers such as are more used in the weaving trade for testing the counts of short lengths of threads taken out of small pieces of cloth.

It should be possible to pull a number of fibres out of the thread and to judge the kind of cotton somewhere near, by the usual finger-and-thumb test and simple observation. Lustre and glossiness of yarn afford some indication of the kind of cotton used, and whether carded or combed. Moreover, the strength tests of the doubled yarn should help also in deciding upon the question of kind of cotton and whether the comber has been used.

Summary of Twisting Effects.

Knittings, mendings, most hosiery, much embroidery, and yarns for mercerising generally, come under the general designation of soft or very soft threads, often from good cottons and gassed, but not necessarily so in lower qualities.

Sewing threads may be classed as medium twisted, inclining to hard in the finishing.

Voiles as hard twisted.

Lace threads medium twisted.

Lisle threads are rather hard twisted.

Much two-fold cotton warp is used in dress goods, cotton velvets, good linings; these are mostly medium twisted.

Double spun yarns as hard twisted.

Heald yarns and fish nets rather hard twisted, but obtaining great strength from manifold doublings.

CHAPTER VII.

CONDITIONING OF YARN.

Given yarn of correct counts the careful and skilful conditioning of cotton yarn improves its working at the immediate succeeding processes. By far the most important of the features of yarn is that of strength, and this rises within limits according to the amount of water added, so that 5 to 7 or 8 per cent. of added moisture may increase the strength per lea of 40's to 60's yarn from 1 to $2\frac{1}{2}$ lb. or so. Each one of the several properties is more or less related to the others, and the increased flexibility of the yarn due to moisture helps the fibres to bend round each other more easily, and to increase the strength by increasing the "coil" friction of the fibres. The elasticity or stretch of cotton yarns is slightly increased by conditioning partly owing to the shrinkage which takes place when the thread absorbs the moisture, since it is well known that 50's to 60's yarn will become about two counts coarser by average conditioning; the increased flexibility also helps in giving increased elasticity. The term resiliency is not often used in connection with cotton yarns, but since it practically means capacity for springing back or rebounding to the touch, it may be taken to be comprised in the terms flexibility and elasticity.

There are now quite a number of methods more or less in use for conditioning cotton yarn, the tendency of recent years having been towards devices for expediting the process on the one hand, or increasing the conditioning effect on the other hand. For many years the very general method was simply to expose the skips of cops in a conditioning cellar for something like a week, and simply to allow the yarn to absorb moisture in a natural manner; and this practice is still largely in vogue, the cellars being often equipped with humidifiers. Sometimes the yarn is watered with a degging can, and sometimes by special hose pipes fitted with spraying nozzles, care being taken to keep the water clean. Dipping the skips, tins, or cages of yarn into a water tank, and winding damp cloths round layers of cops are two of the quickest methods of conditioning yarn. Each firm adopts the method deemed to be most convenient or suited to its requirements.

Since winding deals mostly with warp yarns of reasonable strength, conditioning is not as beneficial to the work at this stage as in the case of weft for weaving.

Methods of Conditioning.

(1) Maturing in conditioning cellar, (2) dipping in water tank, (3) application of watered cloth, (4) mechanical spraying, (5) absorption of vapour by yarn being mechanically passed over a warm water tank, (6) conditioning chambers into which a mixture of water, steam, and air is forced, (7) simple exposure in a steam chest.

The old-fashioned method of placing the skips of cops for four to eight days on rows of bricks in a conditioning cellar is still used by some spinners. Also the quicker methods of "degging" the cops, and the most drastic method of all, viz. dipping the skips, tins or cages of cops completely into water tanks.

Tanking System.

The enamelled ring-frame bobbins especially lend themselves to the tank system. Cops of yarn may be placed in wire cages and dropped into a tank of water for a very short period.

When lifted out the receptacles of bobbins or cops are best taken to a well-ventilated room to give the moisture a chance to spread all through the cops or bobbins of yarn.

Special apparatus is available for reducing the labour, facilitating the work, and improving the results of the tanking system, which apparently increases in favour.

Wet doubling, either on frames or on the twiner, is a species of conditioning. Perhaps slasher sizing may be said to represent conditioning since in heavy sizing 100 lb. of warp yarn may become 200 lb. weight.

The Vapour System and the spraying system are other methods of conditioning yarn, each requiring special apparatus. In the vapour method there is a machine made up of trays held at the out ends of arms of revolving wheels and carried round in a circular path. At their lowest position the cops of yarn are carried over and very close to a vessel of warm water from which rises moisture to give the conditioning. The rotation of this cop wheel facilitates changing the yarn.

In *the spraying method* the cops of yarn are placed on a travelling apron which carries the yarn under spraying nozzles after the style of some humidifiers, the fine spray giving penetration and uniformity in conditioning. The water is forced by a pump from a tank, through a sieve; spare water returns to the tank. The

yarn for conditioning is fed and delivered continuously, the relative speed of yarn through the machine and the spraying power being adjustable.

In March, 1922, the author saw a cabled order from India for a sprayer conditioning machine to go to an Indian mill.

Another machine for yarn conditioning will operate on ring bobbins, mule cops, or reeled hanks, as desired on different lines again from the foregoing, and on large weights of yarn. Suitable wagons are filled with cages, boxes or skips of yarn, possibly six—and run into special conditioning chambers of which there may be three in a set. There are inlet and outlet tubes joining to a fan box. An atomiser operates on a mixture of water and steam from an injecter, and this moisture is forced by the fan draught into the closed chamber and therefore the yarn is conditioned in a few minutes.

The yarn conditioning cellar, with or without mechanical humidifiers and ventilation; the dipping tank, with or without mechanical aids to labour; and the cloth or blanket method are the systems the author has seen most, but others are now in favour.

Blanket System of Conditioning Yarn.

Somewhere about 1895 there was introduced a system of conditioning yarn which became rapidly adopted in this and other countries. The system is still in extensive use and apparently preferred by many, although many others prefer one of the other methods that are available, such as dipping in water tanks, spraying, hosepipe degging, or even the slower exposure in a damping cellar.

As far back as 1880 the author saw weavers dip their newly filled weft skips in the yard well, and this principle has been mechanically developed, and is now a favourite for ring yarn on enamelled bobbins.

Using a water can rose-fitted for degging the yarn is almost as old, and this principle finds its latest exponent in the modern mechanical spraying systems. Watering cans, steam jets, and hose pipes are still occasionally used.

Reverting now to the cloth application system its great defect consists in the time involved in packing the yarn in the conditioning boxes and then having to take out and re-pack for transit. Uniformity of conditioning effect has always been an advantage of the cloth method.

Conditioned yarn does usually work better than dry yarn. In the loom there will be less yarn breakage, fewer snarls and kinks, and probably less waste in using a conditioned rather than a dry yarn especially in some sorts.

The blanket system involves the use of a specially constructed

long deep box, which in its simplest form requires the attendant to dip the cloths or blankets in water and spread them under and over the yarn cops which he packs probably in two rows deep. A number of firms apply this method.

The genuine Pearson machine itself is much more complete.

Besides the specially constructed long conditioning box there is framing to contain a long roll of the cloth, and convenience for passing the same through a water trough and then expressing excess water before the cloth is applied to the yarn either in cop, bobbin, or hank form.

The long sides may consist of boards which can be removed during packing if desired. Capillary attraction of the cotton fibres helps in a uniform spread of the conditioning effect. Steaming, spraying, degging, and dipping are more likely to warp ring bobbins than this milder and slower method. Only hand power is required.

Twelve to twenty-four hours are the usual time limits for conditioning. Applicable to worsted yarns as well as to cotton. Four to eight days are more usual limits for ordinary damping cellar conditioning.

A good man may operate over 1,000 lb. per day per machine of average yarn counts. Large cops and coarse yarns increase productions; more free than some other systems from stain and mildew results. A typical machine may occupy 19 × 4½ feet.

The mode of operation for a properly constructed machine (first introduced by Mr. Pearson) is somewhat as below stated:—

Place lowest side boards in position all the way round and fill up to this height with yarn. The wet cloth passes through the squeezing rollers and is guided over and under and over every double layer of yarn.

Operation repeated, and box sides built up until desired height of yarn is reached.

A layer of cloth comes beneath the first layer of cops.

Arrangements are convenient for easy handling of the cloth.

The cops, spools or hanks may be put on the machine, in one, two or more layers, i.e. two or three deep, between each layer or sheets.

The amount of moisture in the cloth can be regulated.

To ascertain the exact amount of moisture absorbed by the yarn, it will be necessary to weigh it, before and after it is conditioned.

Fill the trough with fresh clean water.

When the machine has been charged with yarn, empty the water trough, so that the sheet will not pass through water when being rewound on the roller, when the machine is being emptied.

On no account must the cloth be wound back on to the roller before the trough is emptied.

Although it is not at all necessary for ordinary yarn, sheets of unglazed paper may be used with advantage, on high-class yarns, or if through any reason, or by accident, the web or sheet of cloth becomes soiled or dirty.

The paper will last several months, three lengths should cover the machine, and they should be wider than the cloth, so as to project 2 inches on each side.

These sheets of paper are to be placed on to the wet cloth when it has been drawn across, before putting the yarn on, and after the layer of yarn is placed, another lot of paper sheets should be put on the top, before drawing the wet cloth across again, so that nothing but pure damp goes through the yarn as the sheet or web of cloth does not actually touch the yarn. Tank immersion and modern conditioning chambers are quicker and less laborious.

Steaming of Cops.

Perhaps the greatest example of the steaming of cops of cotton yarn is to be found in connection with the operation of the twiner doubling machine, and this is diminishing owing to the increasing adoption of the doubling winding frame as a preliminary to the twining operation. Steaming is a particular method of conditioning cops, which has been often found very convenient, very quick, and very suitable for cops of single yarn intended for doubling on the twiner. Take the case of a spinning and weaving concern, spinning yarns for own use, and requiring a large amount of two-fold warp yarns for the selvedges of their cloth or for sale or for other purposes.

It is often very convenient to put up a steam chest in one corner of the twiner-room, or in a room conveniently situated near the twiner-room. In a particular example known to the present writer there was used a strong wood, rectangular steam chest, lined with lead, and capable of holding two skips of cops at one time. A heavy and nearly steam-tight lid was fitted to the steam chest. A steam pipe conducted steam from the steam pipes of the mill whenever a suitable valve was turned on. At the bottom of the steam chest was fitted a plug which could be removed when required to let out the condensed water. Near the top of the chest was a plug or valve which could be opened if required to exhaust some of the steam through a wall pipe into the outside atmosphere. The skips of cops were placed inside the steam chest, steam turned on for possibly three-quarters of an hour or so, with the lid well fitted down; and the effect was in this short time to obtain a most effective conditioning of the yarn. The usual effects of a thorough conditioning were obtained, inasmuch as the tendency of the single

yarn to be curly, snarly, lively, and generally unworkable was greatly checked and reduced.

Steaming may be done either in the case of wet or dry doubling, and in dry doubling especially helps to produce a more uniformly and solidly twisted doubled yarn. A defect sometimes revealed by steaming is the tendency to stain the cops nearest the surface, and especially if the interior of the steam chest is allowed to become dirty and generally out of order. The severe nature of the conditioning in the steam chest, and any possible defects of the process, do not matter quite so much when the yarn is used at the same firm, for selvedges of warps and sized along with the other warp yarn.

The Steam Chest.—An old-fashioned method of quickly conditioning yarn in which slight discoloration does not matter very much, consists in simply placing the skips or boxes of yarn in a lined steam chest. The ordinary mill steam is turned on from 30 to 40 minutes, the box being made practically steam-tight, but with proper outlets for condensed water. A steam gauge is optional.

This method has been much used for conditioning yarn before using at the twiner doubler.

Wet Weft.—Another method of conditioning yarn is utilised by some weaving firms who desire to use wet weft for a limited range of cloths. There are cases in which wet weft may be used for some kinds of towellings, for toilets or piques, and also it was formerly used for some satin quilts if not now.

In such cases, the water is often mixed with soft soap, which helps to make the yarn very pliable for the loom working.

The high number of picks per inch in piques, for example, may sometimes be obtained with less damage to weft yarn by the beating up of the reed, when properly prepared wet weft is obtained. In some towellings some kinds of weft become much more pliable in use, and a better and clearer woven effect is obtained by using wet weft. The conditioning mixture and process may give a brownish linen-like appearance to the weft.

The soap water forming the mixture, and the exposure in a steam chest for 20 to 30 minutes, gives a special conditioning effect. If cops are placed on perforated skewers of special rustless material a better effect is obtained. If conditioned as ordinary weft cops, there may be cop skewering trouble.

Immersion Conditioning (Fig. 53).

Fig. 53 illustrates the working of a yarn conditioning machine for ring yarn. The skips of yarn are placed in the cage, A. To lower cage the tap, B, is opened and all the water which is

in the cylinder, C, and pipes, D and E, runs into water tank, thus allowing ram, F, to ascend and therefore cage, A, to descend into water to condition the yarn.

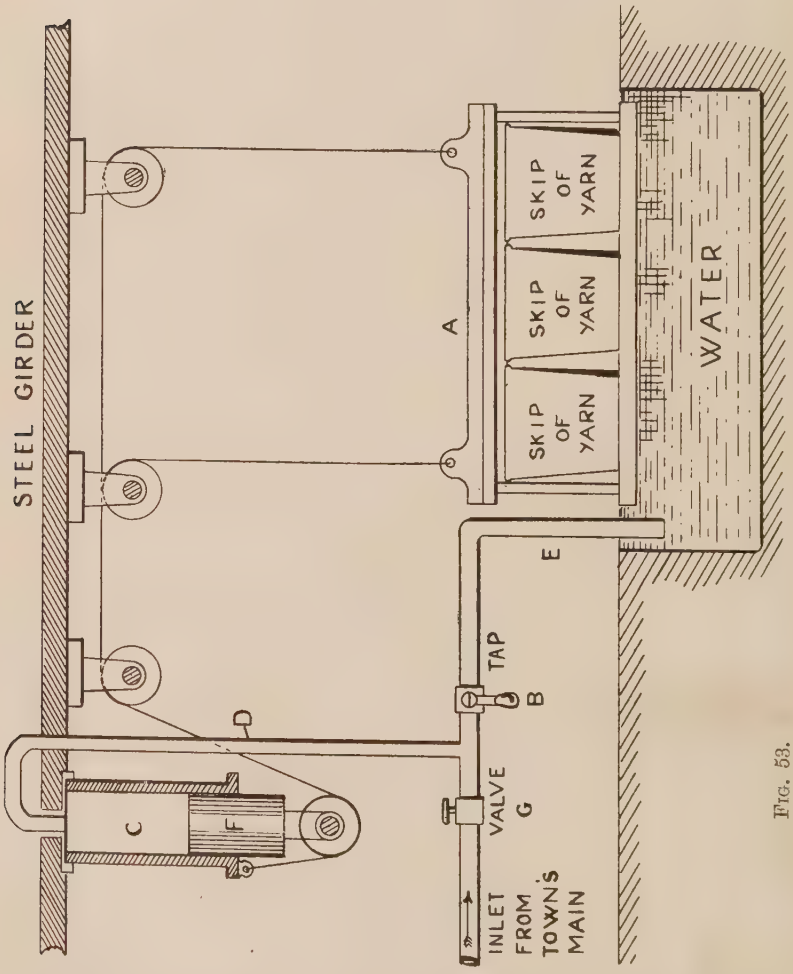

FIG. 53.

After the requisite conditioning has been given the tap, B, is closed and the valve, G, which was closed during descent, is opened. This allows water from the town's main to enter into cylinder, C,

and force the ram, F, down and thus raise the cage, A, and therefore yarn.

This system is much quicker and more efficient than the hand method.

The Use of Chlorides. Conditioning.

The evil has crept into yarn conditioning of damping spun yarn occasionally by treating it with solutions of chloride of magnesium and chloride of calcium. These substances have the power of absorbing moisture, and by their use it is possible not only to add much more water than the cotton should contain, but also to retain this moisture.

These chlorides are readily obtainable by spinners, and much damage may result in the cloth. Damping with these deliquescent substances is far worse than with pure water, often mildew in cloth results.

If the cloth is to be bleached it is certain to be tendered. These remarks may apply also to the use of chlorides in the water troughs of twiners or ring doublers.

Representations by bleachers have led to some weaving mills refraining from using weighting chlorides in the sizing of cloth, and in some cases business has been done only on condition that the yarn has not been treated by chlorides either on conditioning or sizing.

CHAPTER VIII.

RING DOUBLING.

The Ring Doubler.

In regard to weight of doubled yarn produced there is no doubt the ring doubler does more than all systems put together in cotton doubling; although for range of usefulness the flyer frame exceeds the ring and can be used for the finest two-folds, or the strongest fish nets. The ring is the chief machine for doubling in connection with the thread trade. The ring doubler in general outline and principles of operation closely resembles the ring-spinning frame, but always contains expression rollers of one type or another instead of draft rollers. The lifting motion in its simplest form is just a plain heart cam, acting on a plain lever, and moving the lifter up and down in a uniform manner with a straight up and down traverse, and no shaper wheel, the lift keeping one length, and covering the full length of bobbin from empty to full bobbin.

The ring-spinning frame copping motion is rather more complicated than the above, and is sometimes applied to the ring doubler.

When required by modern conditions, extra mechanism is applied to the otherwise plain lifting and cam motion, in order to give a moderate taper at the top of the bobbin; one such mechanism is described later herein.

The gearing in practically all makes differs from the ring-spinning frame in providing for three easily changed driving twist wheels, as against the more usual one in the ring-spinning frame. Twist is the great and almost the only factor of change in an ordinary ring doubler, since there are no draft wheels, and more often no shaper wheels, whilst twist may be either very low or very high per inch.

Creels are adapted to many detailed requirements as explained more fully later. For wet doubling the travellers grip both top and bottom flanges of the ring. Water troughs are used if required.

Winding is accomplished in the same way in ring doubling as in ring spinning. The thread pulls the traveller round the ring, and any easing of the pull, due to roller delivery of thread, results in

loss of traveller revolutions. The traveller holds and guides the thread upon the bobbin, as the latter gains in revolutions over the traveller. Twist per inch is greater for large than for small diameters of bobbin, but no such twist variation appears to give much concern to users or producers of doubled cotton yarns. The rings for wet doubling may need a little application of grease to reduce the friction of the traveller on the ring.

The flyer system does appear to give rather the more uniform twist, and this perhaps helps to keep the flyer in use for such as lace yarns. For all medium ranges of counts and numbers of doublings the ring system scores heavily in production because the flyer is always a great limiting factor in speed. Greater regularity in twist and also in drag certainly help the flyer system.

Both single and double tin rollers are in use for ring doublers, the spindle banding being either the ordinary three-strand or else tubular. Tape driving is gaining somewhat in use for ring doublers in Great Britain, but is yet regarded as a tentative proposition by many doublers. The true figure of eight knot for three-strand or tubular banding is at least as important in doubling as in spinning, and granny knots are to be avoided like the evil one. Slack strings or slack twist, stained, and corkscrewed doubled yarn are anathema in doubled yarn.

Spindle Bands.

Various kinds of spindle banding have been more or less extensively used on ring and flyer doubling frames, the plain thick, three-strand being yet very popular.

Every effort should be taken to have the banders trained to tie true figure of eight knots instead of granny knots.

The figure eight or reef knots, instead of granny or bastard knots, are quite as important for soft tubular banding as for three-strand.

The tubular banding, well tied, gives a soft firm grip on the spindle wharve and helps to give uniform and full twist per inch.

The knot in the tied bands and the loop in loop banding are the most likely points for band breakage, but proper reef knots in the tied band, and loop ends well steeped in tallow in loop banding, are preventives for excessive breakage at loops or knots.

The loops are less severely treated by single tin rollers than by double ones.

Notes.

Thread contraction due to twist may vary from 3 per cent. in soft twist to 6 per cent. in hard twist, on ring doublers.

Ball bearings and self-aligning bearings add greatly to the easy running of the tin rollers of a ring-doubling frame, and are now made to suit almost any kind of bearing. Shrinkage of contraction of yarn due to twist may be restricted by using heavier travellers.

Various couplings have been devised for the bottom rollers of doublers, so that they may be satisfactorily made and coupled up in sections.

Centrifugal and centripetal forces, air resistance, drag on the ring, and pull of thread, exercise their influence on the traveller in ring doublers, as in ring spinning.

Ring grease or tallow is advisable for the rings in wet doubling.

The Ring Doubling Frame.

In ring doublers there are usually three twist wheels easily accessible; a bottom twist wheel which alters both sides of frame at one time, and an independent top twist wheel for each side of the frame so that one side may be different from the other. Sometimes also the tin roller wheel is reasonably convenient to alter. Practically speaking any possible range of twist is obtainable, from the lowest to the highest rate per inch.

Attached pieces are usually planed or milled so that the pieces are readily interchangeable.

Wheels usually have teeth milled from the solid so as to give smooth, sweet running and minimum wear.

For dry doubling top and bottom rollers of polished iron with bottom rollers working in brass bushed stands.

For wet doubling it is customary to cover the rollers with brass tubes.

Water troughs have been made of wood, zinc, or specially hardened brass, but copper troughs are the best. In the English system the glass rods may be lifted out of water when frame is stopped.

The Scotch system gives a wetter yarn and is mostly used for sewing thread, and it is customary to have a handle, worm, and quadrant arrangement for lifting the heavy brass rollers upwards for cleaning or other purposes.

Frames with brass rollers are fitted with a roller traverse motion.

Lappets, thread boards, or glass rods of 1 inch diameter are applied as specified.

Ring doublers may either be fitted with cop-shaping builders, or with building motions which give a straight lift full length all the time.

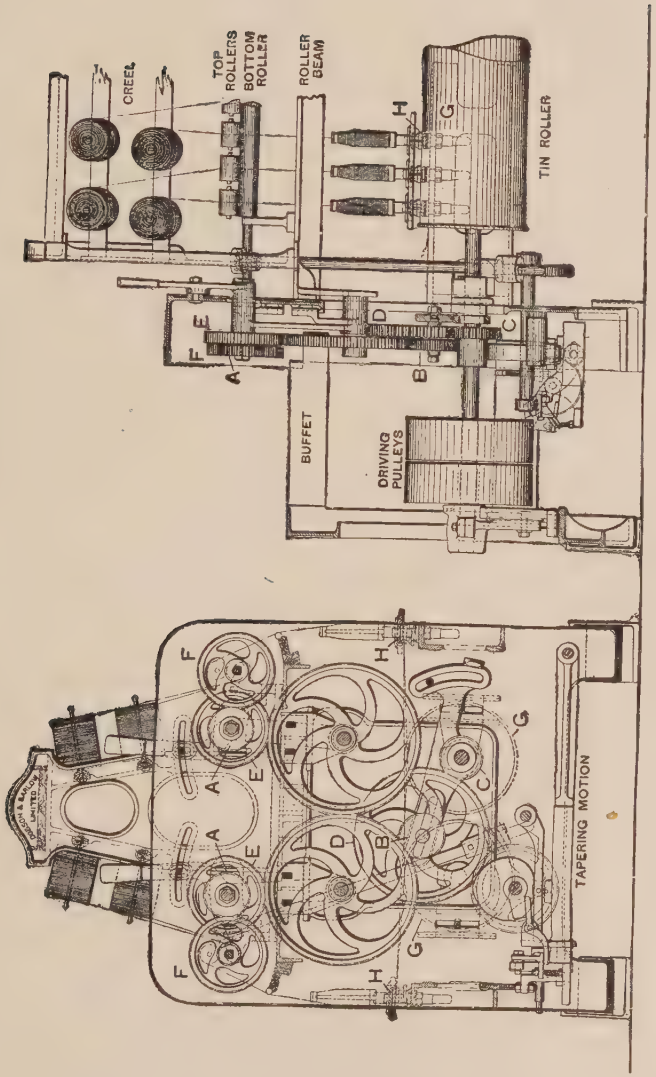
CREEL
TOP ROLLERS
BOTTOM ROLLER
ROLLER BEAM
TIN ROLLER
BUFFET
DRIVING PULLEYS
TAPERING MOTION
A
B
C
D
E
F
G
H

Fig. 54.

References to Gearing of Ring Doubling Frame (Fig. 54, see p. 211).

A Top twist wheel. Change place, 20 to 80 teeth.
B Bottom twist wheel. Change place, 20 to 60 teeth.
C Tin roller wheel.
D Bottom twist carrier wheel.
E Top twist carrier wheel.
F Front roller wheel.
G Tin roller.
H Spindle wharves.
J Bottom roller.

Specification Items.

No. of frames.
Space of spindles.
Dia. of spindle wharve.
Revs. of spindles per minute.
Spindles to run Weft way or Twist way.
Dia. of drum on main shaft.
One or two tin rollers.
Nos. of yarn to be doubled.
Dia. of bottom roller.
Wet or dry doubling.
No. of spindles in frame.
Length of lift.
Dia. of ring.
Revs. of main shaft per minute.
Dia. of pulley on tin roller.
Dia. of ditto.
Twist per inch.
Ditto top roller.

Calculations.

$$\text{Speed of spindles} = \frac{\text{Revs. of G} \times \text{dia. of G}}{\text{Dia. of H.}}.$$

$$\text{Revs. of Front Roller} = \frac{\text{Revs. of C} \times \text{C} \times \text{B} \times \text{A}}{\text{D} \times \text{E} \times \text{F}}.$$

$$\text{Turns of spindle for one of front roller} = \frac{\text{F} \times \text{E} \times \text{D} \times \text{G}}{\text{A} \times \text{B} \times \text{C} \times \text{H}}.$$

$$\text{Twist per inch} = \frac{\text{F} \times \text{E} \times \text{D} \times \text{G}}{\text{A} \times \text{B} \times \text{C} \times \text{H} \times \text{J} \times 3{\cdot}1416}.$$

$$\text{Twist wheel A} = \frac{\text{F} \times \text{E} \times \text{D} \times \text{G}}{\text{Twist} \times \text{B} \times \text{C} \times \text{H} \times \text{J} \times 3{\cdot}1416}.$$

$$\text{Twist wheel B} = \frac{\text{F} \times \text{E} \times \text{D} \times \text{G}}{\text{A} \times \text{Twist} \times \text{C} \times \text{H} \times \text{J} \times 3{\cdot}1416}.$$

Productions of Ring Doubling Frames.

(Messrs. Dobson & Barlow.)

Twist per inch based on the following rule: $\sqrt{}$ counts when doubled × 4·5. If the twist per inch is increased or decreased, the productions will, of course, be decreased or increased proportionately.

The sizes of bottom rollers, as stated below, are for the English system of doubling; where the Scotch system of doubling is required, the bottom roller in each case will be 2½ inches diameter.

Counts and Number of Folds.	Speed of Spindle.	Lift.	Space.	Diameter of Ring.	Diameter of Bottom Roller.	Twist per Inch.	Hanks per Spindle in 10 Hours.	Lb. per Spindle in 10 Hours.	Hanks per Spindle per Week of $56\frac{1}{2}$ Hours.
		Ins.	Ins.	Ins.	Ins.			Lb. for No. of Ends.	Single Ends.
2/10's	6,000	5 or 6	3	$2\frac{1}{4}$	2	10·03	10·50	2·10	59·32
3/10's	5,500	5 or 6	$3\frac{1}{4}$	$2\frac{3}{8}$	2	8·19	11·78	3·54	66·56
4/10's	5,000	5 or 6	$3\frac{1}{2}$	$2\frac{3}{4}$	2	7·06	12·43	4·97	70·23
2/12's	6,000	5 or 6	3	$2\frac{1}{4}$	2	10·98	9·58	1·59	54·16
3/12's	5,500	5 or 6	$3\frac{1}{4}$	$2\frac{3}{8}$	2	9·00	10·72	2·68	60·61
4/12's	5,000	5 or 6	$3\frac{1}{2}$	$2\frac{3}{4}$	2	7·78	11·27	3·76	63·69
2/16's	6,500	5	3	$2\frac{1}{4}$	2	12·69	9·17	1·15	51·80
3/16's	6,000	5 or 6	3	$2\frac{1}{4}$	2	10·35	10·37	1·94	58·58
4/16's	5,500	5 or 6	$3\frac{1}{4}$	$2\frac{1}{2}$	2	9·00	10·94	2·73	61·82
2/20's	6,500	5	$2\frac{3}{4}$	2	2	14·22	8·34	0·83	47·15
3/20's	6,000	5 or 6	3	$2\frac{1}{4}$	2	11·56	9·47	1·42	53·54
4/20's	5,500	5 or 6	3	$2\frac{1}{4}$	2	10·03	10·00	2·00	56·54
2/24's	7,000	5	$2\frac{3}{4}$	2	2	15·57	8·20	0·68	46·32
3/24's	6,500	5	3	$2\frac{1}{4}$	2	12·69	9·35	1·17	52·82
4/24's	6,000	5 or 6	3	$2\frac{1}{4}$	2	10·98	9·97	1·66	56·33
2/28's	7,000	5	$2\frac{3}{4}$	2	2	16·83	7·74	0·55	43·74
3/28's	6,500	5	$2\frac{3}{4}$	2	2	13·50	8·95	0·97	50·58
4/28's	6,000	5 or 6	3	$2\frac{1}{4}$	2	11·88	9·40	1·34	53·10
2/32's	7,500	$4\frac{1}{2}$	$2\frac{1}{2}$	$1\frac{3}{4}$	2	18·00	7·75	0·48	43·78
3/32's	6,500	5	$2\frac{3}{4}$	2	2	14·67	8·24	0·77	46·59
4/32's	6,000	5	3	$2\frac{1}{4}$	2	12·69	8·78	1·10	49·63
2/36's	7,500	$4\frac{1}{2}$	$2\frac{1}{2}$	$1\frac{3}{4}$	2	19·08	7·31	0·40	41·3
3/36's	6,500	5	$2\frac{3}{4}$	2	2	15·57	7·75	0·65	43·85
4/36's	6,000	5	$2\frac{3}{4}$	2	2	13·50	8·26	0·92	46·69
2/40's	8,000	$4\frac{1}{2}$	$2\frac{1}{2}$	$1\frac{3}{4}$	2	20·11	7·54	0·37	42·6
3/40's	7,000	5	$2\frac{3}{4}$	2	2	16·42	7·92	0·60	44·74
4/40's	6,500	5	$2\frac{3}{4}$	2	2	14·22	8·50	0·85	48·02
2/50's	8,000	$4\frac{1}{2}$	$2\frac{1}{2}$	$1\frac{3}{4}$	$1\frac{3}{4}$	22·50	6·73	0·27	38·02
3/50's	7,500	5	$2\frac{3}{4}$	2	2	18·36	7·75	0·46	43·67
4/50's	7,000	5	$2\frac{3}{4}$	2	2	15·88	8·35	0·66	47·17
2/60's	8,000	$4\frac{1}{2}$	$2\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	24·61	6·14	0·20	34·69
3/60's	7,500	5	$2\frac{3}{4}$	2	2	20·11	7·07	0·35	39·94
4/60's	7,000	5	$2\frac{3}{4}$	2	2	17·41	7·61	0·50	42·99
2/70's	8,000	$4\frac{1}{2}$	$2\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	26·59	5·70	0·16	32·20
2/80's	8,000	$4\frac{1}{2}$	$2\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	28·44	5·32	0·13	30·05
2/90's	8,000	$4\frac{1}{2}$	$2\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	30·15	5·02	0·11	28·39
2/100's	8,000	$4\frac{1}{2}$	$2\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	31·81	4·76	0·095	26·90

Frames are made either with single or double tin rollers. The tin rollers are of strong tinned steel plates, and are carefully made and accurately balanced. An improved tape driving arrangement with tension pulleys, for driving two spindles by one tape from a single tin roller, can be applied if desired.

Tin roller shafts are usually provided with self-oiling bearings on the Mohler principle.

For wet doubling, the ring plates are made of wrought-iron, and are planed to fit on milled surfaces on the pokers.

By means of the poker feet, the adjustment of the ring plate is so made that the pokers may be removed for cleaning and replaced, without disturbing the height of the plates.

In some cases the pokers have flat feet, which rest on anti-friction bowls in the ends of the lifting levers.

A rope driving arrangement can be applied if desired. With this arrangement of driving, instead of the pulleys being fixed on one of the tin roller shafts in the usual way, an intermediate shaft is placed on the frame, and from this shaft both tin rollers are driven by a rope with a tightening apparatus. This enables a quick speed to be attained from a slow driving shaft, and the speed of the spindles may be altered by simply changing the driving rim on the intermediate shaft. This method of driving ensures very regular twist, as both tin rollers are driven from the same source instead of one roller being driven by the other.

Self-contained flexible spindles of various patterns can be supplied.

Various styles of creel can be applied for doubling from winder's bobbins, cops, ring bobbins or cross-wound cheeses.

Possible Extras.

Spindles with internal screw oil cups.

Spindles with cast-iron or wood sleeves for doubling on paper tubes.

Knee brakes for spindles.

Tape driving for spindles.

Steel lappets on angle-iron rails for dry doubling.

Brass lappets on angle-iron rails for wet doubling.

Separators of various types.

Zinc splash plates with trough behind spindles for wet doubling.

Compound building motion to make bobbins tapered at both ends.

Oil drip tins under gearing end and tin roller bearings.

Patent rope driving at gearing end.

Pulleys for rope driving from mainshaft.

Rope driving and tightening apparatus for 2 tin rollers at out end.

Indicators of various patterns.

Middle gearing for rollers, so that four kinds of twist can be made on one frame.

Doubling Systems.

In one sense there may be said to be three systems of doubling, viz. the flyer throstle, the twiner, and the ring doubler systems. From another point of view we may say there are two systems of doubling, viz. :—

1. Direct doubling and twisting from the mule cops or ring-frame bobbins on the doubling machine, which may be any one of the three above mentioned.

2. Using the doubling winding frame, and performing the actual doubling on this machine, leaving the twisting only for the doubling machine.

All this is apart from any detailed modifications of any one of the three doubling machines themselves, such as the English and Scotch systems of ring doubling; the latter being understood to give more watering effect to the yarn than the former.

The flyer throstle is the oldest of the three primary systems, but is limited in spindle speed. Its special advantages are the production of a very round and solid yarn, and adaptability for doubling extremes of counts, so that its chief vogue is found in doubling lace yarns on the one hand, or coarse yarns with many doublings on the other hand for such purposes as netting and tyre yarns.

The twiner has the advantage of putting the doubled yarn into the form of cop which suits many customers. Also it gives a somewhat fuller or more hairy yarn than the other two, and this suits many customers for use in two-fold warps.

The ring doubler is the most used of the three, and is the simplest machine of the three. It is eminently suited for the production of sewing cotton from two to six or more cord, and especially when used in combination with the doubling winding frame. It is much more productive than the flyer throstle, and more adapted to the strong doublings required for sewing and crocheting cottons than is the twiner.

Sewing Thread v. *Lace Yarns.*

Taking up the proposition after the actual doubling and twisting of the yarn the processes of doubling, winding, and twisting will be left out.

A principal operation for much sewing thread after the final

doubling consists in passing it through a polishing machine—a process entirely different from that by which a polished effect is produced on yarns for the lace trade. Referring to the "glacé" thread, a warp or chain of ends is prepared from the required number of bobbins—possibly 360 or so, and this warp is probably bleached or dyed as a good deal of sewing cotton is required in various colours.

It may be that the doubled yarn is linked up into the form of a chain warp, which presents the yarn in perhaps the most suitable form for passing through the bleaching and dyeing processes. The chain warping process links up the warp of a comparatively low number of threads—when compared with a beam warp for weaving—so that we are prevented from obtaining an inordinately long and cumbersome warp while maintaining the loose nature of the threads requisite for permitting the liquid to act on every part

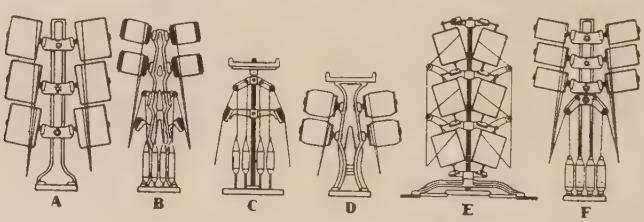

FIG. 55.

Creel A is for cheeses of yarn.
,, B for either cops or flanged bobbins.
,, C specially for mule cops.
,, D ,, ,, flanged bobbins.
Creel E specially for almost vertical cheeses.
,, F specially for almost horizontal cheeses. Also cops.

of the yarn equally. Afterwards the yarn may be wound on a beam which is placed in suitable bearings at the polishing machine, the threads are drawn off and passed through the polishing mixture, and are then subjected to the action of high speed bristle brushes. Following this process comes the spooling operation, which puts the sewing cotton into suitable form for the market. In an alternative system the doubled yarn may be reeled into hanks, and bleached and dyed in the hank form before winding, polishing, and spooling. For "soft" sewing cotton the polishing process may be omitted.

With regard to lace yarns the process immediately following doubling consists in winding the yarns upon large flanged bobbins on a vertical spindle single winding frame. Not only does this process place the yarn in good quantity upon bobbins convenient for subsequent use, but the yarn is also cleared and freed from bad ends, and an eye is kept upon any big knots.

Creeling Arrangements.

There are several detailed arrangements of creels more or less in use for doubling frames, depending upon the form in which the yarn is supplied to the machine, the chief forms being mule cops, ring bobbins, flanged warper's bobbins, quick traverse winding frame cheeses.

Several sketches in the flyer and ring doubler sections illustrate this point, but the main types have been assembled by an eminent firm as shown in Fig. 55 at A, B, C, D, E, F.

Scotch and English Systems of Wet Doubling.

The English doubler has the rollers carried on stands fixed to the roller beam, but the rollers are not in the water at all. There is a glass rod placed in the water trough, under which each thread passes before reaching the rollers. There are means for raising the glass rod out of the water for cleansing and other purposes. Each thread passes from its creel bobbin, under the glass rod, under and half round the bottom brass roller, over the top roller, and then down to the twisting spindle. In the Scotch system of doubling, the threads pass first beneath the rollers and then between them, and the bottom one of the pair is placed adjustably in the water. The threads are usually kept longer under the water in the Scotch system than in the English. The principal difference, then, between the two systems will be found in the size and shape of the water trough and the position of the guide rollers. There are no draft rollers in either system. The Scotch system is chiefly used by the Scotch makers of sewing thread, and gives a wetter yarn than the English system.

The accompanying Figs. 56 and 57 illustrate the different systems of doubling, and are practically self-explanatory, the passage of the yarn from creel bobbin to twisted doubling bobbin being clearly shown.

The several methods of guiding doubled yarns, of which four arrangements are shown in Figs. 56 and 57, and the large range of counts, say from 4's to 120's, to double from, necessitate the making of these machines of a variety of gauges with different sizes and shapes of creels, spindles, and bobbins. The system of doubling in some threadmaking establishments is to wind by means of stop-motion doubling winders, two, three or four ends from ring-frame bobbins on to warpers' bobbins, which, when full, are placed on the ring doubler creel ; one bobbin supplying one doubling spindle with yarn to have the necessary twist put in ; thus a twisted thread is produced.

If the creel becomes too high for economical working, the hands

not being able to replace the bobbins easily, and a stop-motion not being applied usually to the machine, irregular thread is made owing to ends breaking and escaping the attention of the minders until a considerable length has been twisted and irreparable mischief done. Other arrangements of creels and methods are em-

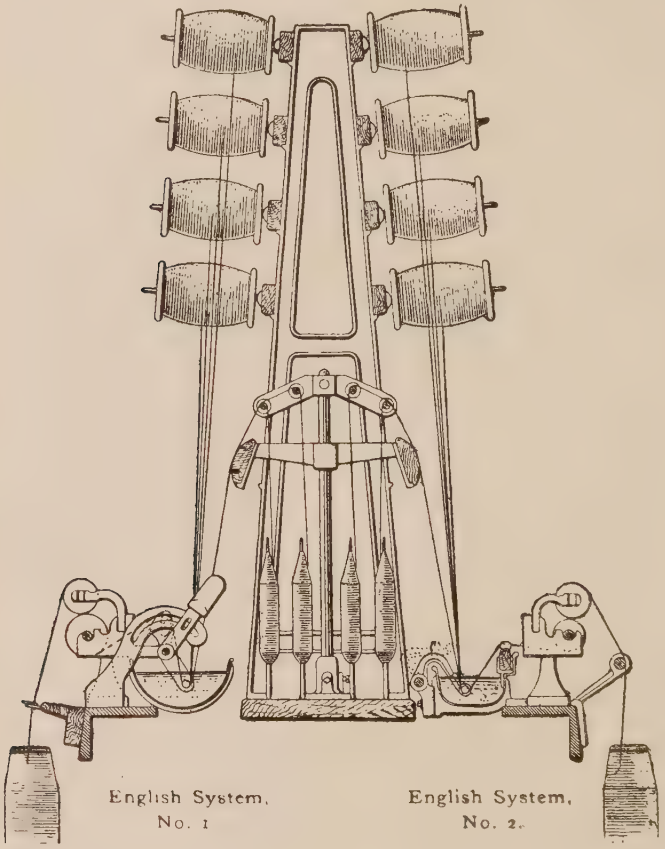

FIG. 56.

ployed, but those mentioned are mostly called for. As regards gauges these generally commence at $2\frac{1}{4}$ inches for the very fine thread, and they rise in six advances up to 4 inches gauge, which latter is used for making very strong thread, heald yarn, fine cord, etc., the intermediate gauges being used chiefly for the numerous

qualities of thread, crochet yarn, and special work. In the fine gauge frames a light running 5-inch lift spindle is used, and in the intermediate gauges generally a 6-inch lift. It may be stated that there are twisting machines with stop-motions.

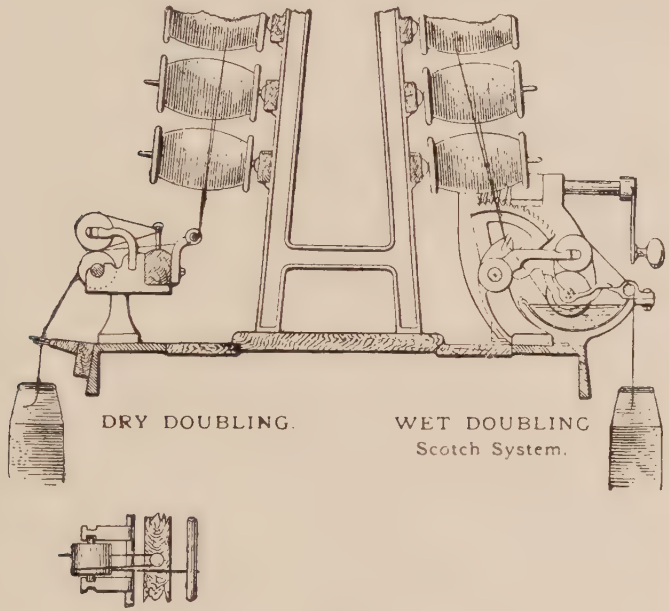

FIG. 57.

Doubling Spindles.

There are several points that are necessary in a good spindle, and a few might be mentioned :—

1. Light running.
2. Steadiness under high speed, which is tested by running with unbalanced bobbins.
3. Simplicity of construction.
4. Non-liability to get out of order.
5. Capability of running for lengthened periods of time without cleaning, lubrication or other attention.
6. And, as important as any, cheapness.

Knee Brake.—For heavy doubling, when specially ordered, a knee brake is applied, enabling the attendant to stop any spindle with a little pressure of the knee. For the finer gauge frames, and

frequently for coarse gauges, the knee brake is not essential, and the wider wharve on spindle is recommended, which amply serves for stopping the spindle.

Scotch v. *English Systems of Wet Doubling.*

The main difference between the Scotch and English systems of doubling consists in the fact that in the Scotch system the conducting or brass expression rollers revolve inside the water troughs, whereas in the English system these rollers are placed quite outside the water troughs and distinctly nearer to the vertical line of the spindles. The revolution of the brass-covered rollers in the Scotch system taking place at least partially inside the water, there is a tendency to get more watering effect on the yarn; while it also materially assists in obtaining a narrower frame. In the English system the threads pass underneath a glass conducting rod immersed in the water, and an arrangement is now generally provided for lifting the whole of the glass rods out of the trough by a handle at the frame whenever it is required for cleaning purposes. Similarly in the Scotch system there is an arrangement at the frame end for lifting the brass compression rollers out of the trough for cleaning, etc. Not only are these rollers usually covered with brass in both systems to prevent corrosion, but also in the Scotch system the brackets in the copper water troughs may be of brass. The yarn, in passing from the creel to the spindle, may come off the creel bobbins sideways, pass downwards and under the glass rod in the water trough (English system), then over a glass guide and underneath the lower of the two brass rollers, back again between the two rollers, over the upper roller, and thence down to thread wire, through the traveller and upon the bobbin. This is what may be termed the inwardly revolving system, in which both rollers appear to turn inwards when looking from the front of the machine. In some cases these rollers revolve in the opposite direction.

Fish Nets.

Necessarily, fishing nets require to be exceptionally strong, and they also require to be very pliable and supple in the finished thread, so as to be free from tendency to curl and twist up, which would help to make the net to become entangled in itself. 20's/21-fold or 21/21-fold will give a very good netting, and is in frequent demand. In the manufacture of 20's/21-fold netting we might take American, single yarn spun twist way, and make in the preparing process into seven-cord twisted twist way, with a good proportion of twist, equal, in fact, to ordinary sewing cotton.

Afterwards in the finishing doubling three of the seven-cords would be put together and twisted weft way with only a moderate amount of twist. The opposite twisting in the finishing stage and the smaller amount of twist per inch tend to produce a balance of forces in the finished thread, and give such a suppleness that the article is very workable, and free from curl even when in hank form.

Dry Doubling.

Dry doubling is often done for doubled warp yarn, knittings, mendings, grandrelles, hosiery, and, generally speaking, yarns in which softness, fulness, and cover are required. A fancy goods doubler, or one who deals in soft or mixed goods, may abstain from the dirt, trouble, and expense of using water troughs.

For many cloths in which two-fold cotton warp is used, the dry doubling enhances the full soft feeling of the woven cloth—a feature still further developed by using the twiner for the doubling process. Twiners may be conveniently adapted either for wet or dry doubling, the same as frame doublers and twiner yarn for warps or selvedges of warps is sometimes wet doubled.

A twiner will also supply the doubled yarn in cop form if desired.

While dry doubling enhances the qualities of softness and cover or full feel and appearance, wet doubling will consolidate the thread, permit of the drag and twist necessary for obtaining the maximum strength and concentration in the thread, and yet limit the snarling and crimping of the yarn.

These latter qualities find chief expression in sewing cottons, and it is seldom if ever these are dry doubled.

Working of Doubling Frames.

In the case of a doubling frame it is necessary first of all to keep the rollers and the spindles thoroughly well oiled and cleaned, and we may include with these all the parts of the copping motion. The bearings of the bottom rollers may be oiled every other day or so for ordinary work, bearings on frame ends and tin rollers once a week, and all geared, cleaned, and re-greased once in a while. Special ring grease should be regularly applied to the rings in wet doubling. The twist is of first importance on a doubling machine, and so the proper size of twist wheel should be put on; also every care should be taken to have the spindle bands all of sufficient tension to prevent much slippage, and yet not so tight as to break the bands and cause the frame to run heavily. In wet doubling rings and ring rails should be thoroughly cleaned about once per week, water run out of troughs, glass rods lifted clear, and all parts well cleaned. To give proper spinning and twisting it is well also to test spindles and

rings for concentricity, to keep all travellers of equal and correct counts, to prevent the threads from working in worn or cut positions in the glass rods and thread wires. See that excessive vibration of spindles is prevented. Bad spinning, unequal twisting, weaker threads, uneven breakage of yarn, dirty yarn, too many piecings, and restricted production are resultant evils of neglect of above precautions.

Some Uses of Doubled Yarns.

No machine facilitates the production in quantity, quality, and variety of "fancy effect," or novelty yarns, better than the doubling frame. An ordinary plain doubler may have special mechanisms attached to it for fancy effects, but the greatest range effects is produced by using the fancy yarn doubling machine.

100's/2 may be used either for voiles or for the lace trade, but in the former case the doubling twist is the same way as the spinning twist giving a very hard, clear, concentrated effect in blouses or other materials, while offering conspicuous wearing merits and durability. In the lace trade the doubling twist is opposite from the spinning twist. The wiry hard twisted nature of a voile two-fold makes it very liable to snarl or loop.

Voile yarn may be wound upon pirns for use as weft or made into warps for use as warp.

Mercerising, bleaching, and dyeing afford excellent chances of producing special effects in voile cloths.

Poplins may take two-fold warps of 60's to 80's counts and gassed. The weft is much coarser in either two or three-folds, plain woven, but transversely ribbed by the yarn differences.

Fine crepe yarns may range up to 136's/2-fold hard twisted up to 70 turns per inch, probably on the added doubling twist system adopted for voiles. Weaving one end per dent enhances the clear voile effect.

Thread Stop-Motion.—The method of stopping a doubler top roller when an end breaks, by using a long wire and allowing a leather tongue to pass between top and bottom rollers has been superseded in many cases by the more recent short brass sleeve system.

For each top roller, there is a thin brass sleeve mounted loosely on and revolving with the bottom roller. The brass sleeve is not a tight fit on the bottom roller, but has its inside diameter $\frac{1}{32}$ inch larger than the bottom roller diameter, the brass shell being $\frac{1}{16}$ inch thick. Each brass sleeve is flanged and contains one top roller nicely fitting between the flanges. One of the flanges is cut. The nebs of the cap bars carry small brackets upon which are fulcrumed detector wires one for each doubled thread or top roller, each wire resting upon its own thread. It is necessary

to understand why each brass sleeve is $\frac{1}{32}$ inch larger bore than the diameter of bottom roller. Each top roller rests on its sleeve and keeps the sleeve in full biting and running contact with the bottom roller, so that the top roller is properly rotated through the medium of its loose brass sleeve.

When a thread fails or breaks its detector wire falls into one of the cuts in the notched flange of sleeve and stops the sleeve from turning, and therefore stops the top roller from revolving. The detector wire is designed to keep the broken thread out of contact with other threads or any revolving rollers.

Stop-Motion Twister (Fig. 58).

It has always been possible to obtain machines in which both the doubling and twisting are done on the same machines. Creels have been previously shown to hold cops or ring bobbins of single yarn. Fig. 58 shows a machine specially adapted for two-folds in which a peculiar type of single bobbin stop-motion is utilised.

The two yarns are carried around the leather-covered delivery roller, A, over the balanced lever, B, to the twisting bobbin. When one yarn fails the other unspins and allows the lever, B, to rise at its front end until the upright part on B comes into the path of the cam formed on under side of the delivery roller, A. The delivery roller, acting on B by its own revolution, draws itself out of gear with the bevel pinion, C, and stops, thus waste and laps are prevented. When the end has to be pieced, the worker, by means of the lever, D, puts the brake, E, on the spindle. She then depresses the lever B, which carries the lever, D, along with it, thus starting the delivery roller and the spindle simultaneously.

The fibre of each yarn is wrapped round itself before the two yarns are twisted together. This is done by the downward rubbing of the yarn on the leather-covered delivery roller on its passage to the lever B, thus making smoother yarn.

Band Tensioning.—The bands before being put on are stretched with a given weight, and there are printed on them two marks indicating where the knot must be, in that way ensuring all bands are of equal length. The spindle rails, F, are made in sections, about 5 feet long, and instead of being fixed to the framing may be carried on swing levers, G, which, by means of the weights, H, press the rails outwards and give all the bands a continuous tension. This arrangement maintains the fixed minimum driving power decided upon for the spindles, and greatly reduces the total power required for a frame, particularly in damp weather.

When yarns are required above two-ply they can be double wound on bobbins or cheeses and twisted on the above frame,

with the advantage that roller laps will be entirely prevented and all the waste in front of the feed rollers saved.

Top rollers of doubling frames are self-weighted and are sufficient to grip the yarn with the required firmness without any external weighting.

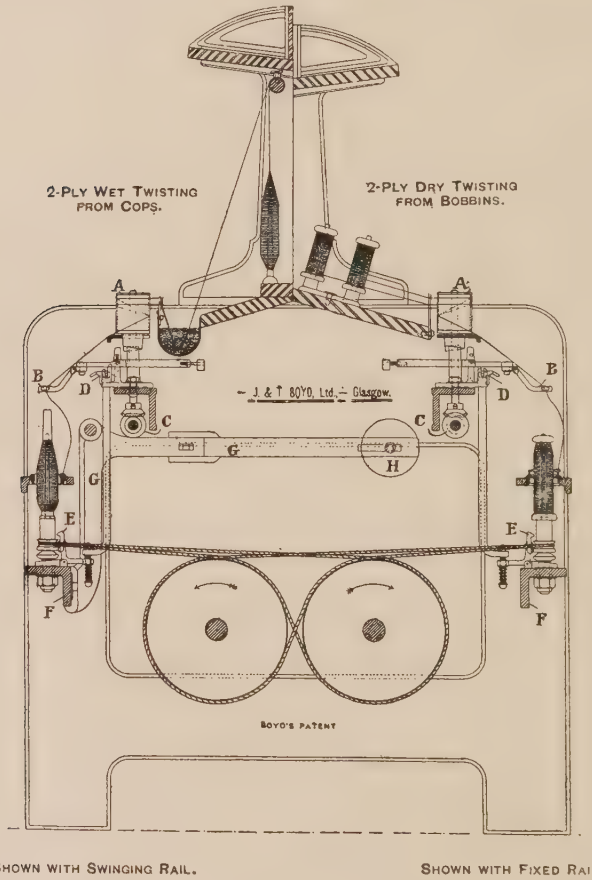

FIG. 58.

Direct twisting from mule cops or ring-spinning bobbins is diminishing, and when it is done the cops or bobbins may be placed vertically and have the yarn drawn over the upper end, a suitable creel being adopted. Warpers' bobbins and quick traverse cheeses are usually revolved by the unwinding of the yarn, the porcupine

creel containing several rows of bobbins or cheeses if only single end winding has preceded, and fewer rows if doubling winding has preceded. A correct angle of yarn from rollers to front guide rod or thread wire is beneficial to the process.

Merits and De-merits of Direct Doubling and Twisting.

The most apparent advantage of the stop-motion twisting frame is that it helps in attaining certain doubling effects without the expense and trouble incurred in the purchase and manipulation of doubling winding frames. Direct doubling and twisting is sometimes done without using a stop-motion, but compels extra vigilance on the part of the operatives to prevent the making of single or excess doubled yarns, or roller laps. In this particular make of stop-motion twister it is arranged for each bobbin to stop if one of the two component threads becomes broken, and the manner of stopping is somewhat as follows : There is placed behind the rollers a framework containing two or three detectors for each finished thread produced, according to the number of threads doubled together. Each single thread is passed through the detector in a well-known manner, and failure of a thread permits a detector to drop into the path of a revolving cam shaft which pushes the top roller away from the bottom roller, so as to prevent further delivery of the yarn. At the same time the spindle band is slackened and held so as to stop that particular twisting spindle. The net result is that the broken thread is left behind the roller ready for re-piecing, and there is avoidance of bunch knots and waste, as well as in the amount of single yarn. The twisted threads at the front of the rollers pass through an aperture in a starting lever, and should the thread balloon very greatly, or should a traveller fly off, the lever will lift up, and will stop the spindle. A similar thing occurs if there is a roller lap. The doubling winder method is most used.

An advantage of this method—as compared with the use of the doubling winder—is that small quantities of many sorts or varieties of doubled yarns can be conveniently produced. Any method of direct doubling and twisting requires much more attention from the operatives than does a doubling frame operating from bobbins or cheeses produced upon a doubling winding frame.

Glass Guide Rods.

To prevent grooving of the glass guide rods, the rods may be slightly moved sideways or slightly turned round occasionally, but in some cases revolving glass guide rods have been adopted and offer the best preventive of nicking or wear, and avoiding the danger of bad work or thread breakage from worn rods.

Lappets.

Lappets are not always used, but are applied when required and may be of wood. For wet doubling brass lappets are sometimes called for, and a special form of brass lappet contains an adjustable slotted plate instead of the thread curl.

Flyer frame spindles are usually longer than ring-spindles and the use of the flyer limits the r.p.m.

Special Type Ring Doubler.

A very special form of ring doubler has been put before users of late years, and differs fundamentally from accepted ideas in ring spinning and doubling.

The bobbin spindles are retained and pass vertically up and down between the rings, the bobbins being connected to the spindles by pegs or nugs after the style of roving frame bobbins upon their driving bevels. The bobbins and spindles are not definitely driven but are drawn round by the thread, as the bobbins are on a flyer throstle frame. The bobbins can easily be lifted from the spindles whatever the method of connection between the two.

Each ring, with its connected traveller, takes the place of a flyer in the flyer throstle frame, and is definitely driven round by a band from the tin roller instead of the spindle being thus driven. Each spindle contains a flange for a drag band to act against so that the spindle and bobbin shall not be pulled round too easily by the thread. The rail containing the spindles and bobbins is made to travel up and down instead of the usual ring rail in order to traverse the yarn along the length of bobbin.

Twist Per Inch.

In calculating spindle speeds and twist per inch it is the more correct method to add one diameter or thickness of spindle band to both the tin roller and spindle wharve diameter.

It is sometimes very useful for a doubling foreman to calculate and tabulate a list of top and bottom twist wheels and twist per inch given by any one combination.

Twisting.

Cotton doubling primarily consists in twisting yarns together in order to produce a thicker one possessing properties of strength, suppleness, beauty, or other quality not obtainable by direct spinning.

Other operations have often to be considered in the light of how they affect the twisting process.

Relative proportions of twist, direction, and amount of twist in actual spinning, in P.P.G. and in finishing, always dominate and influence to a large extent the marketable article finally produced. Twisting is of fundamental importance in the doubling trade, and is varied to a large degree to suit different requirements.

A frame doubler is usually fitted with no less than three easily changed twist wheels, the bottom twist wheel altering both sides of machine equally and simultaneously, while the two top twist wheels each affect one side of frame only. These three wheels afford a very wide range in amount of twist, but do not always represent the absolute limits.

A soft twisted single yarn will often give a better effect in the doubled thread. Increased twist makes yarn darker.

Twist Shortens Yarn.—Let the reader take a few yards of ordinary mill banding $\frac{3}{8}$-inch or $\frac{1}{2}$-inch diameter—as the present writer has done several times—untwist and split the strands away from each other, and he will be astonished at the increase in length of the unravelled strand as against the $\frac{3}{8}$-inch or $\frac{1}{2}$-inch finished cord.

This point may need attention both in the processes preliminary, and those subsequent to doubling twisting, and is naturally affected by the amount and direction of twist at the doubler. For example, it may be necessary to use a 62's single yarn to produce a true 30's two-cord, showing accurate twist per inch. At one time the author produced in the mill a large amount of two-fold 20's from 41's/42's single.

In the same way doubled yarn may stretch in such subsequent processes as reeling or gassing, affecting both counts and twist per inch in the final resultant thread.

In some cases about 6 per cent. more twist is put in at the doubling frame so that a sample of gassed or reeled yarn may show correct specified twist under the twist tester.

In XX twist a loss of strength may result from distortion or breakage of fibres.

Twist testing instruments of simple construction will usually do very well for counting or testing the turns per inch in doubled thread, a needle or pointer serving to separate the threads and show when all the twist is correctly taken out.

Such instruments are much more difficult to operate satisfactorily in judging the twist in single yarns owing to yarn becoming very soft and slack when the twist is extracted.

Slack and greasy strings at one machine or another, give reduced and varied amounts of twist per inch.

Actual twist on a doubler may be 4 or 5 per cent. less than calculated. One spindle often gives 6 or 7 per cent. less twist than another.

Tubular banding is supposed to give good twisting results. With double tin rollers, the off-side line of spindles may give rather less twist than the positively driven side.

Soft twisted single yarn is required to produce a really good six-cord sewing thread.

Three-cord sewings require much the same amount of twist as ordinary or "usual" two-cords.

For sewing cotton two-fold P.P.G. is twisted same way as the single yarn, the final twisting being opposite.

In nine-cord sewings we should get 3 × 3 times and in twelve-cord 4 × 3. Four-cord may be made either by cabling 2 × 2 or at one four-fold operation.

The nine-cord might take 2·6 in P.P.G. and 2·3 finishing, while the twelve-cord takes less, say 2·3 P.P.G. and 1·7 finishing.

On twist constants students or others could work out tables of twist per inch for different classes of doubling.

For sewing threads P.P.G. the twist is twist upon the single twist, while for crocheting the P.P.G. twist is opposite from the spinning twist.

Twist, twist weft for sewings. Twist, weft, twist for crocheting, the latter giving perhaps a rather fuller and softer effect, and the former helping the strength wanted from sewing cottons.

In calculating twist per inch from a constant, we should take $\sqrt{\text{counts doubled}} \times$ constant, and not square root of counts single.

Speed of Lift.

In frame doubling finer yarns require slower lifter speeds than coarser yarns, to keep a good degree of spiral in disposing the threads on the bobbin.

An actual lifter traverse may be $\frac{1}{16}$-inch to $\frac{1}{8}$-inch shorter than bobbin.

A quicker lift in ring doubling gives a quicker change at longest length of yarn and thus limits ballooning of threads at the point and prevents greasing or breaking of threads.

Rusting of Spindles.

At various machines in the fine doubling trade objection is sometimes taken to operatives with perspiring hands, owing to danger of rusting spindles, guide rods or other parts, and resultant bad work. The same objection applies to some operatives in spinning as on draw-frames, combers or ribbon machines.

Testing.

In testing for strength the finer threads may be tested for the $\frac{1}{4}$ lea, $\frac{1}{2}$ lea or lea, according to counts and capabilities of machine.

For the stronger, coarser, and heavier yarns, the method of single thread testing is often adopted, and both single thread testers and twist testers are suitable for doubled yarns.

These strength and twist testers are of most service after a frame has been altered from one sort to another, and tests should then be made from several bobbins.

Double Spinning or Double Twisting.

Sometimes double spinning is resorted to in order to obtain specific effects in three-cord sewings. The exact best proportion of twist in the single can only be determined by testing the different effect of different twist constants in the single, followed up through the double spinning result.

Revolving Rings.

Various attempts have been made to spin or twist yarn on ring-frames containing revolving rings. In one example the ring and thread guide are driven directly from the tin rollers instead of the spindle being driven. Spindles are necessary to hold the yarn bobbins and are still encircled by the rings; the spindles being much of the ordinary kind but without wharves for spindle bands. The bobbin and spindle fit together so that the dragging round of the bobbin by the thread also means rotation of spindle.

A thread tension device is fitted to each spindle. The spindle has a vertical up and down movement.

Obviously such a method amounts practically to reversing and transposing the duties of spindles and rings as commonly understood.

Flanged Bobbins.

In the case of two-fold warp yarn placed on doubled flanged bobbins after twisting and in readiness for making warps of two-fold yarn; such yarns are much stronger than ordinary single yarn for weavers' warps. It is suggested that the flanges should be tapered from $\frac{1}{2}$-inch thick at the root down to $\frac{1}{4}$-inch at the final edge or rim. This tapering of flanges is all the better for keeping flanges clear of drums in drum winding, the bobbin flanges are perhaps less liable to break, and the tapering tends to prevent strong two-fold yarns when tightly wound, from pushing the bobbin ends off when stored for a time.

Doffing of Ring Doublers.

Small girls and lapper's-on often go from frame to frame on definite system of doffing.

This system is very much easier when counts of yarn, number of doublings, size of doubled cops or bobbins are reasonably equal, than when all these and other conditions vary, and so disturb the doffing sequence. An experienced and competent woman charge hand is especially useful for superintending the doffings and girl doffers when conditions vary considerably.

Before a frame is ready for doffing the girls may place empty bobbins on a suitable rail.

A frame should be stopped for doffing with the lifter near centre of bobbin length and the threads then broken off just above the bobbins.

The bobbins are now removed from spindles to proper doffing skips or tins.

For wet doubling the rings may now be greased.

A lapper-in will take an empty bobbin and wrap the thread from the rollers round the bobbin, slip the thread under the traveller, and firmly place the pieced up bobbin on its spindle, several lapper's-on working together on one frame. Five or six minutes for doffing a frame with competent lapper's-in.

Tapering Motion for Ring Doublers.

Object.—As illustrated in Fig. 59 this motion is used chiefly for fine doubling and is in favour with some firms. By this means a straight lift bobbin is built up with a coned upper end which is very suitable for end unwinding at the next process. In this case no top flange is required on the bobbin, the bobbins can be doffed at any time without affecting the shape, and lifter rails need to be set at the bottom only.

The motion is simple, durable, and effective.

Reference Letters.—A, cam lever; B, chain block; C, chain to alter length of lift; D, guide bracket for chain; E, adjusting screw; F, chain lever; G, small heart cam; H, ratchet wheel; I, feed lever; J, ratchet wheel pawl; K, adjustable finger on upright rod; L, upright rod; M, short chain; N, long chain to quadrant; O, quadrant; P, adjustable poker foot; Q, poker to lift ring rail; R, ring rail.

Operation.—The short chain, M, is the ordinary lifting chain, and the long chain, C, is applied for varying the extent of lift, both chains being fastened to the block, B.

The lift reaches the base of the cop cone every lift, but only reaches the apex of the cone once in several lifts with number of lifts proportionate between these two extremes. The effect of only placing yarn once after several lifts at the apex of itself produces the cone shape of cop or bobbin. At the beginning the coning chain C acts very little on block, B, and the shortest lift

is produced. The shaper wheel, H, brings the cam against lever, F, and shortens chain, C, so that block, B, on end of long lever, is

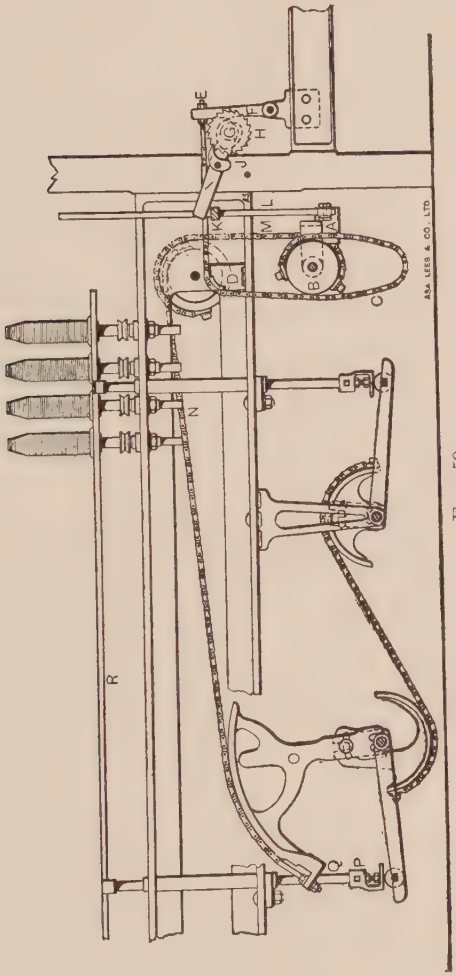

FIG. 59.

made to pull more of chain, M, from block, D, and raise the lifter traverse at top. Full part of cam at H gives maximum lift. Cam may have several revolutions for one full bobbin.

Threading of Yarn Round Rollers.

Various methods are excellently shown in Fig. 60 as made by Messrs. Asa Lees & Co., Oldham.

1. Rollers running inwardly, with drag peg, yarn delivered from top roller.

2. Similar to No. 1, but without the drag peg, yarn delivered from *the top.*

3. Rollers running outwards with drag peg, yarn delivered between the rollers. In this case the same yarn passes *twice* between the pair of rollers.

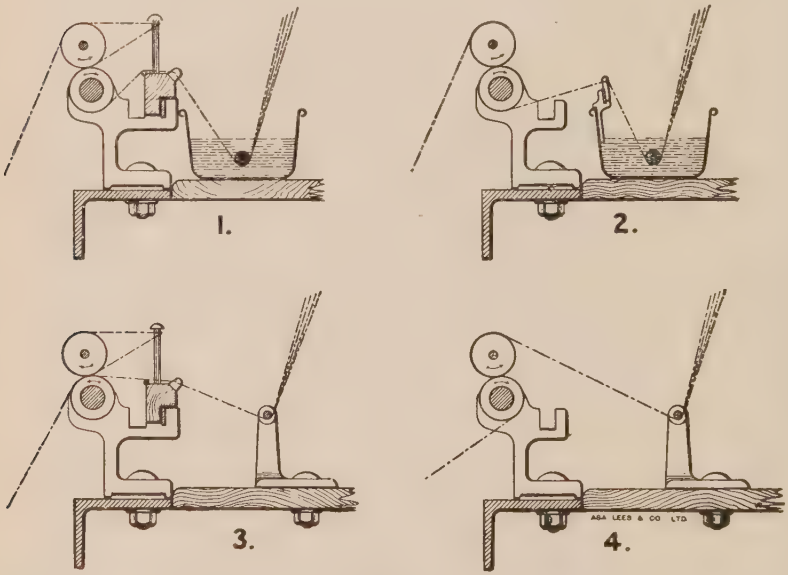

FIG. 60.

4. Rollers running inwards, no drag peg, yarn delivered from the *bottom.*

Twist in Single and Double Yarns.

The chief effect produced on the single thread by the doubling twist, is that when twisted or doubled the same way as spun, each single yarn retains its full spinning twist, at least, besides participating in the doubling twist as a component part thereof; whereas, when the doubling twist is put in the opposite direction each doubling twist takes one twist out of each single yarn. When

twisted in the same way the two-fold thread is darker and altogether more intractable unless fixed in some way, whereas with the opposite twisting the tendency for untwisting in the single thread is balanced by that of the doubled twist, so as to produce a permanent set, so that this opposite twisting is common for two-folds for warp and lace purposes. The same way of twisting is in extensive adoption when the two-folds have to be made into four-folds or six-folds for the purposes of sewing thread in which the second doubling twist is in the opposite direction, and this method gives a strong concentrated sewing thread. The single threads often receive the opposite twisting when intended for re-doubling for the fuller but possibly more polished crocheting cottons.

If only one doubling and twisting be resorted to the same direction of doubling twist will give a more concentrated and possibly a stronger thread, but a more unruly one to handle.

Calculation.

The gearing of a ring-doubling frame is arranged as follows: A pinion of 20 teeth on the tin roller shaft drives a carrier wheel of 90 teeth, with which is compounded the bottom twist wheel. This twist wheel drives through two single carrier wheels a stud wheel of 50 teeth which is compounded with the top twist wheel. The top twist wheel drives a wheel of 50 teeth on the front roller of 2 inches diameter. The twist wheels range from 20 to 50 teeth in each instance. The tin roller is 6 inches diameter, and the spindle wharves 1 inch diameter. Find the top and bottom twist wheels to give 20 turns per inch, and state how you would re-arrange these particulars to obtain 40 turns per inch, retaining the same range of twist wheels as before.

The double twist wheel idea—each wheel being a driving one—is almost peculiar to the doubling frame, and somewhat complicates the question of finding the proper twist wheels. The following method is adopted because of its simplicity:—

$$(a)\ \frac{1 \times 6}{1} = 6 \text{ revolutions of spindle for one of tin roller,}$$

and it is to be noted that 6 inches is a very small diameter of tin roller, 8 inches for single and 10 inches for double rollers are more used.

In the same way a simple statement could be made showing the inches delivered per one revolution of tin roller.

(*b*) It will simplify matters if now we assume the bottom twist wheel to contain 25 teeth, this being inside the specified range of 20 to 50.

$$(c)\ \frac{1 \times 6 \times 90 \times 50 \times 50 \times 7}{1 \times 20 \times 25 \times 2 \text{ in.} \times 22} = 20 \text{ turns per inch.}$$

(*d*) Therefore $\frac{\text{dia.} \quad \text{pi.}}{1 \times 6 \times 90 \times 50 \times 50 \times 7} = 21{\cdot}4$ top twist wheel.

We might really apply a 21 top twist wheel to allow for slip of spindle band.

With regard to 40 turns per inch a general statement may be made that any one of the twist wheels may be made half-size in order to get double twist, or the top and bottom twist wheels may have the effect divided out between them. A larger diameter of tin roller would, of course, produce the same effect by speeding up the spindles, only while the small twist wheel does the work by reducing the speed of delivery rollers.

Requirements for Mercerised Yarn.

We require to produce a 2/80's mercerised yarn—(*a*) Quality of the cotton and details of the spinning of the single yarns; (*b*) method of doubling and the twist coefficient for this purpose; (*c*) details of the processes subsequent to doubling and before mercerising, and the objects of these processes.

(*a*) For 2/80's yarn for mercerising good Egyptian cotton is probably most in demand, and it gives the best results when the cotton is combed and the single yarn is soft twisted with a twist multiplier of possibly 3, taken into the square root of the counts. For an extremely good quality Sea Islands cotton might be used since it is well understood that the better the cotton and the lower the twist, the more perfectly will the mercerising effect be produced, and Sea Islands will work with a less amount of twist than any other cotton. There is often considerable strain put upon the yarn in the caustic soda bath, so the quality of the cotton and the amount of twist must be sufficient to withstand this, and a little more twist than quoted above may be sometimes necessary unless the cotton and its treatment be very good.

(*b*) As regards the method of doubling it is quite possible to make a two-fold in one operation either on the continuous or intermittent system of doubling, but the more recent practice of using first the doubling winding frame and then the doubling machine, appears to be always increasing in favour. The twisting for the two-fold may be opposite from the single yarn and the twist kept down as low as subsequent strain on the yarn will permit, say, the square root of counts doubled × 3 to 4 or so, according to circumstances.

(*c*) After doubling, the yarn may be cleared upon large pear-shaped bobbins which may be taken to the gassing frame, and will last a considerable time while permitting a high speed with end unwinding. Gassing removes the loose fibres and permits greater

lustre in the mercerising process. After gassing the yarn may be reeled into hank form, and sent to the mercerising department.

Uses of Yarns.

Counts and qualities of yarn in the production of (*a*) tyre cloths, (*b*) knitted goods, and (*c*) heald yarns, and essential characteristics of each. How the spinning and subsequent processes should be conducted in each instance to attain the desired results.

Tyre cloths vary in quality and price, whether intended for bicycles or motor cars, but speaking generally, they require very good yarns although not necessarily very fine. Very best tyre cloth may be manufactured from yarns spun from Sea Islands cotton, combed, and in exceptional cases, double combed; much more is from other cottons. Counts according to amount of doubling, say often 23's/40's. A wider range of counts is permissible with hosiery, and a wider range of qualities. 20's to 36's yarns from good Indian or ordinary American cotton are often knitted into cheap under pants and cheap stockings, but prices of knitted goods and therefore the qualities of the yarns required may readily be double or even treble the above, and for such yarns spun from Egyptian cotton are often used. The term "Balbriggan" is sometimes given to fine underwear knitted from Egyptian cotton yarns. Such yarns are even sometimes mixed with silk for the best underwear, commanding greatly enhanced prices, but not requiring very fine counts. Knitted goods are generally prepared from yarns spun with as little twist as may be convenient in order to retain the quality of softness, whereas yarns for tyre cloths may be harder twisted.

(*c*) It is very desirable that good healds for weaving purposes should be as strong, smooth, and pliable as can be conveniently attained. Healds are made from different materials, but are very frequently made from doubled cotton yarns; the single yarns, however, need not be very fine, since the finished doubled thread may be somewhat coarse, and may be varnished to aid in obtaining strength and smoothness. Heald yarn may be doubled either on the ring doubler or the flyer doubler, and in one case it is recommended for 30's/3 or 36's/3 preparing to use a twist multiplier of 5 and for nine-cord finishing. A multiplier of 8, in each case taking this into the square root of the counts doubled. 23's/12-fold is a strong line for tyre yarns.

Samples.—It is possible to attach an arrangement for making samples to the last section of bottom rollers in a doubling frame.

The wheels can be varied to suit the testing and sampling required, and small quantities or samples of doubled yarn produced,

containing different amounts of twist per inch, and different from what is being produced on the rest of the frame.

Hand of Frame.—Face the centre of gearing end, glance lengthwise of the frame, and note whether the driving pulleys are on your left or right hand, this fixing the designation.

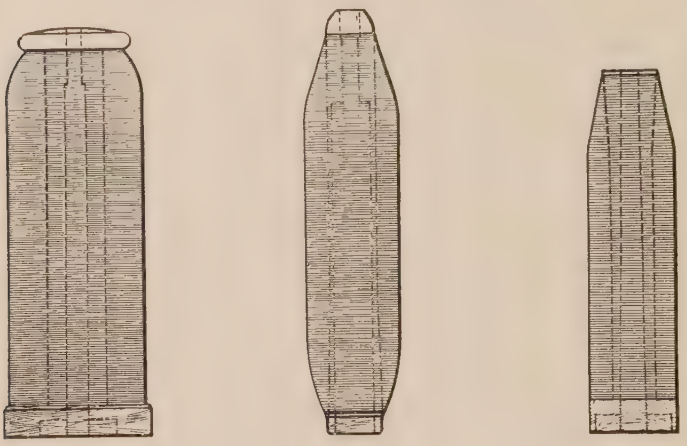

FIG. 61.

Types of Ring-Frame Bobbin.

The leading types are nicely shown in Messrs. Asa Lee's diagram (Fig. 61).

On the left the ordinary straight left type, using an empty tube slightly thinned towards the top, the apex of the heart cam giving a slightly accelerated speed of lift at the top.

Centre view showing the shape obtained by using an ordinary ring-spinning cop shaping motion and gradually building up from base to apex, with a shaper wheel, raising and shortening motion.

The taper top, on the right hand, giving an excellent bobbin for end unwinding without "ringing off" of coils, and obtained by using a special motion as elsewhere explained in this chapter.

Frame and Gearing Details for Doublers.

Gearing.—In modern doublers great care is taken to make parts interchangeable, the parts being, as far as practicable, turned, bored, and milled to templates.

In some cases, at any rate, wheels other than change wheels at the gearing end, are most carefully and accurately fixed in non-adjustable positions so that the teeth are always in exact gear at

their "pitch lines" and can scarcely be disturbed. The change wheels, of course, must be in adjustable centres.

Gearing wheels are often cut out of the solid metal—one firm doing this for all wheels making above 5 r.p.m.

Spindle Rails.—Spindle rails and beams are all accurately milled to gauges, and brackets have milled facings to permit close and accurate fitting to their places.

Rings of doubling section may be fitted into wrought-iron rails; since cast-iron is considered too weak for the rail section required for this class of ring.

Tin Rollers.—On occasions tin rollers may have interlocking joints purporting to give a more even surface for spindle bands than does the overlap joint.

Tin roller pedestals are made on the self-lubricating principle. The pedestals at the gearing or large frame end may have cavities in which run collars which are part of the tin roller shaft, and therefore hold the tin rollers in exact position lengthwise instead of by ordinary collars. Oil is conveniently carried round the bearings. For centre bearings of tin rollers oil-pipes may reach from the creel boards.

English v. *Scotch. Wet and Dry Doubling Systems.*

For the most part, frame doublers are made in three ways: (1) Wet on the English system. (2) Dry on the English system. (3) Wet on the Scotch system. In dry doublers there are no copper troughs, and the yarn passes from the creel bobbins, between two conducting and delivery iron rollers, thence to the twisting spindles.

In wet doubling on the English system the yarn passes through under glass guide rods or hooks placed in a water trough, the depth of immersion being usually adjustable. In this system the expression or delivery rollers are fixed in front of the water trough or nearer the twisting spindles.

The distinctive feature of the Scotch system—so-called because of its extensive use by Scotch makers of sewing thread—is that the expression rollers are placed inside the water trough, so that the lower roller is more or less immersed in the water.

By means of a worm and worm-wheel arrangement the heavy rollers can be raised or lowered so as to give the required depth of immersion of bottom roller. A simple handle or lever arrangment only is necessary for the lighter immersion rod of the English wet system.

The Scotch system gives a wetter yarn than the English and is the more used of the two, being particularly suited for most

kinds of sewing cotton. The rollers can be raised high enough to give dry doubling if desired.

The use of glass conducting rods, copper water troughs, and brass-covered expression rollers, prevents corrosion and consequent staining of the yarn. Doublers may be made in gauges from $2\frac{1}{4}$-inch with $1\frac{1}{2}$-inch rings, up to $5\frac{1}{2}$-inch gauge with $4\frac{1}{2}$-inch rings. Even these dimensions have been exceeded.

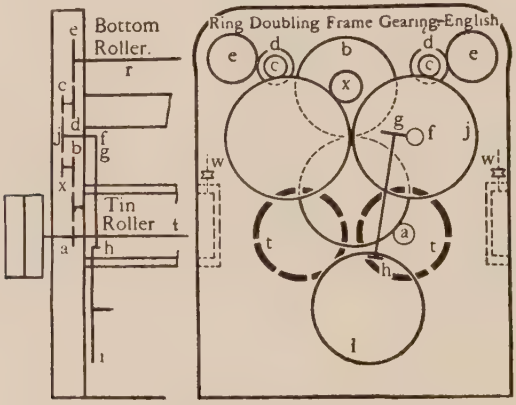

Fig. 62 (Tweedale & Smalley.)

Gearing.

a	25 tin roller wheel	driving	100 twist wheel carrier	*b*
x	Twist wheel	,,	60 side twist wheel carrier	*c*
d	65 or 25 side twist wheel	,,	100 or 35 bottom roller wheel	*e*
x	Twist wheel	,,	100 arm wheel	*j*
f	Worm	,,	22 worm wheel on upright	*g*
h	22 bottom upright bevel	,,	120 heart motion wheel	*i*
t	10-inch tin roller	,,	Spindle wharve	*w*
r	Diameter of bottom roller	,,	Twist per inch	T

Calculations.

To find the twist wheel, twist per inch, and a constant equal to the two multiplied together :—

$$\frac{1 \times e \times c \times b \times t}{r \times 3{\cdot}1416 \times d \times x \times a \times w \times \mathrm{T}} = \frac{\text{Constant}}{x \times \mathrm{T}} = 1.$$

Therefore,

$$x = \frac{\text{Constant}}{\text{T}} \text{ and } \text{T} = \frac{\text{Constant}}{x} \text{ and Constant} = x \times \text{T}.$$

Twist Constants.

Wharve . .	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{3}{4}$	2	Wheels.	
Roller . . .	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	e	d
	1397	1222	1086	978	889	815	699	611	100	25
	537	470	418	376	342	313	268	235	100	65
	188	146	146	132	120	110	94	82	35	65

The range of wheels for twist wheel (x) is 65 to 22, and for side twist wheel (d) from 70 to lowest possible.

Spindles.—In the frame of Messrs. Tweedale & Smalley the spindle is fitted with an automatic holder, and is of the gravity or self-adjusting type, the inner tube having a spring held in position by being "sprung" into two under-cut portions of a recess. This does away with the rivet which has often caused trouble when making mill repairs.

Spindles are fitted with knee brakes when required as for heavy doubling.

Long Lift Motion.—A variable long lift motion is applied when required. It is applicable to either doubled, flanged, or other bobbins.

The principle is utilised of always the lift to reach the lowest winding position on the bobbin, but varies its highest point of lift or reversal.

In one frame this is brought about by a scroll being turned a portion of a revolution (at each rotation of the heart).

The barrel of this scroll being on an incline (when the ring-rail is at the top of the lift) shortens or lengthens the highest lifting point of rail according to the position (in the scroll) of the sliding block to which the lifter chain is attached.

The cam motion always rises and falls to the limits it is set out for.

In principle of top cone formation, the result is somewhat similar to that in building bottle bobbins on the vertical spindle clearing frame.

Motor Tyre Fabrics.

There are chafer, breaker, and building fabrics.

A square woven cloth of 17½ oz. per square yard for building. For breaker 10 to 12 oz. and for chafer 9¼ oz.

Cottons used include combed sakel, other combed Egyptian, carded Egyptian, and either carded or combed Peelers' American.

Yarns for chafer fabric may be from 16's counts, 5 ends, with 6 turns per inch to 23's, 5 ends, with 7 turns per inch.

American Egyptian cotton from Métafifi seeds has come into use in some mills, having a staple of 1½ inches and opening a good 72's doubling weft, although looking somewhat speckled in the bale.

Tangiers Peruvian from Sea Islands seed also commanded a good deal of attention during 1922, also for 72's doubling weft.

Using self-weighted middle top rollers on Jack frames and mules and setting front and middle rollers inside the staple length, has come more and more in vogue for such cottons.

CHAPTER IX.

ARRANGEMENT OF MACHINERY.

Mill and Machinery Arrangements.

As in the case of spinning mills, one of the first conditions in arranging for a new doubling mill, is to obtain a good idea of the site itself and its general suitability in regard to sub-soil, water supply, size and shape of site, position in regard to roads, railways, supply of the yarn required for doubling, and to the markets for the doubled and twisted yarns.

Where there is sufficient available land, it is generally conceded that a shed building is best for a doubling concern, as it affords great facilities for transferring the material from one stage to another, gives good lighting, is more readily managed and controlled, and offers a firm basis for the machinery. The author has known a second floor to be vibrated considerably by an unsteady twisting frame having tin rollers out of order.

The sub-soil should be of a solid nature even if only a shed building be required and a clay sub-soil is considered good.

In some cases doubling concerns do their own bleaching and dyeing of finished doubled yarns, and the necessity for a regular supply of good clean water becomes still more important than usual, although this point requires attention in every case.

Electric Driving.

This is obtaining increased adoption in doubling mills, and ring doublers especially lend themselves to individual motor driving as the present author can testify from personal experience.

There are three fundamental principles which make it convenient on ring spinning or ring doubling frames for individual electric motor driving.

1. The very central position of the tin rollers.

2. The normal approximate speed of such tin rollers may be from 600 to 850 r.p.m., and these speeds are suitable for the direct coupling of individual motors of reasonable size and cost.

3. Unlike such machines as openers, cards, fly-frames, and mules, a ring-frame may be started very promptly without inconvenience.

One firm alone has applied individual direct motor drive to doubling frames representing 50,000 spindles at the time of writing these notes. Many frames, however, yet retain line shaft driving either from steam engine or electric driving. Line shafts and collective driving may suit most of the machines of a doubling mill as also in the case of spinning mills.

Line shaft speeds have been recommended as follows: doubling frames 300-350. Clearing frames on the vertical spindle type, quick traverse winding frames, gassing frames, all these about 250 r.p.m.

The line shaft for reels might be 250 as above, but if convenient may have a lower speed down to 200 r.p.m. or lower.

The doubling frames are sometimes very well driven by means of gallows pulleys, one line shaft to drive two rows of doubling frames. They are much heavier to drive than any of the other machines above specified which may all be readily driven by half or quarter crossed belt.

Specifications.

When the machine maker is required to draw up the plans and set out the machinery and shafting for a new doubling mill, he should be supplied with such information as the following:—

The kind of building whether it be storeyed, part of an existing building, or shed.

An outline plan of the site and position from which the water will be utilised.

The range of counts it is expected to double and the approximate average counts of yarn it is proposed to use and produce.

The weight of yarn it is expected to produce in a given time—say per week, and the number of spindles it is proposed to instal.

It is perhaps advisable to specify what line or lines of trade it is proposed to cater for: such as lace, hosiery, tyre yarns, sewing thread, warps, healds, crocheting, etc.

Also whether the doubled yarns will be plain or gassed, and what form the doubled yarns will be delivered in; such as long or short bundles; beam, ball or other form of warp; quick traverse cones or cheeses.

When it becomes a case of actual and detailed arrangement of machines, many other details relating to each type of machines require to be specified.

Approximate Powers Required.

	H.P.
Warp ring-frame, 5″ lift, 6,000 revs., 120 spindles per	1
,, ,, ,, ,, ,, 7,000 ,, 100 ,, ,,	1
,, ,, ,, ,, ,, 8,000 ,, 90 ,, ,,	1
,, ,, ,, ,, ,, 8,500 ,, 80 ,, ,,	1
,, ,, ,, ,, ,, 9,000 ,, 70 ,, ,,	1
S.A. twiner, 1½″ gauge, 9,000 to 10,000 r.p.m., 100 to 120 spindles ,,	1
Cotton ring doubler (ordinary), say 50 to 70 spindles ,,	1
Boyd's S.M. ring twister, 3,300 revs., about 40 spindles ,,	1
Ring doubler, woollen doubler pattern, 40-60 ,,	1
Cop reels, 10 machines	1
Double bobbin reels, 5 machines	1
Bundling press	⅕
Warp winding machine, 200 spindles	½
Drum winder, per 60 drums	¼
Pirn winding machine, per 100 spindles	½
Warping machines, 6 machines	1
Slasher sizing machine, 72″ and 48″ cylinders, for looms 52″ reed	1½
Plain calico looms, 3 to 4 machines	1
Cloth folding machine	½
Hydraulic cloth press	1

Division of Machinery.

It is well to state the approximate percentage of each class of doubled yarn it is proposed to produce.

Example.—A mill proposing to specialise in two-fold warps, might suggest as below :—

4	per cent. of average 2/100's
10	,, ,, ,, ,, 2/90's
18	,, ,, ,, ,, 2/60's
60	,, ,, ,, ,, 2/36's
8	,, ,, ,, ,, 2/26's.

Typical examples of the special uses of two-folds would be in the lace trade for Nottingham; the warp trade for Bradford; Nelson, Bolton, and other centres for voile two-folds. Some of above two-folds would be required plain and others gassed.

In the case of a doubling mill it will be sometimes awkward to make exact calculations of quantities and productions owing to fluctuations in the details of orders.

In one case of almost 4,000 vertical winding frame spindles the setting-out included 62 per cent. chiefly for clearing purposes,

13 per cent. for winding only, and the remainder for both clearing and winding, making bobbins for warping frame creels.

Fans.—A ring spinning or ring doubling room is often improved in working conditions by having one or two fans which may be driven from a convenient line shaft or by electric current. The walls or windows in which they are placed should be the most suitable for giving maximum effect, and it is no worse if they are on a private side of the mill.

Ventilating humidifyers are sometimes used.

The following has been suggested as the equipment for a substantial shed building for the production of sewing threads, crochet, and similar lines, from two-folds up to twelve-folds.

2 single cop vertical spindle winding frames 360 spindles $4\frac{1}{2}$-inch lift.

20 drum winding frames, each 118 drums 5-inch traverse, cop creels.

6 drum winding frames, each 118 drums 5-inch traverse, with creels for doubling bobbins.

20 ring doubling frames 316 spindles, $2\frac{1}{4}''$ space, $1\frac{1}{2}''$ rings.
20 ,, ,, ,, 296 ,, $2\frac{3}{8}''$,, $1\frac{5}{8}''$,,
40 ,, ,, ,, 300 ,, $2\frac{1}{2}''$,, $1\frac{3}{4}''$,,
40 ,, ,, ,, 300 ,, $2\frac{3}{4}''$,, $2''$,,
8 ,, ,, ,, 240 ,, $3''$,, $2\frac{1}{4}''$,,
8 ,, ,, ,, 260 ,, $2\frac{3}{4}''$,, $2''$,,
12 flyer ,, ,, 316 ,, $2\frac{1}{4}''$,,
8 ,, ,, ,, 200 ,, $3\frac{1}{2}''$,,
2 ,, ,, ,, 180 ,, $4''$,,
14 clearing frames, 312 spindles each, $4\frac{1}{2}''$ space.
6 ,, and winding frames, 312 ,, ,, $4\frac{1}{2}''$,,
4 winding frames, 312 ,, ,, $4\frac{1}{2}''$,,
14 quick traverse winding frames, 120 drums.
46 double, 40 hank reels.
6 circular warping mills.
6 chain ,, ,,
12 single preparing machines.
4 bundling presses.

A practical man or a good student may learn a good deal from the analysis and consideration of such a table as above. Relative proportions of different sorts of machine, kinds of machine, details of size, space, length of lift, are all of great importance in actual practice. Naturally the ring doublers with the least spindles and widest spacing would be for the coarser counts and for second or finishing doubling. The flyer frames might be for the finishing process when cabling is resorted to, and the first or P.P.G. is done on the finer spaced frames. Frame doubling direct from cops has much diminished, but creels must be adapted to this if required.

High creels especially are required when direct doubling and twisting are done on the same frame, from flanged bobbins wound single end.

Messrs. Brooks & Doxey give the following specification of a plant for sewing thread, including carding, spinning, doubling, bleaching, dyeing and making-up.

A perusal of this is educationally valuable.

Sewing Cotton Plant.

To produce 6,150 lb. of thread, average 36's 3-fold per 56½ hours.

Specification of Machinery.

1 single opener with porcupine feed table.
2 single scutchers (1 intermediate and 1 finisher).
15 carding engines, 37 inches on wire for 37½-inch laps.
3 sliver lap machines.
24 combers, 6 heads each.
2 drawing frames, each with 3 heads of 5 deliveries per head, (= 10 finishing deliveries).
2 slubbing frames of 94 spindles each, 17½-inch gauge, 10-inch lift.
5 intermediate frames of 126 spindles each, 26-inch gauge, 10-inch lift.
15 roving frames of 106 spindles each, 20½-inch gauge, 7-inch lift.
26 ring spinning frames, of 380 spindles each, 2½-inch gauge, 1½-inch ring, 5-inch lift.

Doubling :—

23 doublers, 380 spindles each, 2½-inch gauge.
7 doublers, 344 spindles each, 2¾-inch gauge.
3 doublers, 316 spindles each, 3-inch gauge.

Finishing :—

3 patent winders, 120 bobbins, 4½-inch traverse.
1 upright clearer, 300 spindles (patent taper motion).
6 double 40 hank reels.
2 hank winders, 70 drums, 5-inch traverse.
18 bobbin to bobbin polishers.

Bleaching and Dyeing :—

2 open top steel kiers.
2 sour chemic cisterns.
1 centrifugal pump.
4 four reel washing machines.
1 ten reel hank dyeing machine.
3 four reel hank dyeing machine.
1 soaping and washing machine.

1 set of cast-iron indigo vats.
1 circular wood cistern.
1 indigo grinding mill.
6 dye tubs.
2 36-inch hydro extractors.
2 hank stretching machines.

Spooling and Balling :—

14 ten spindle spooling machines.
2 Ferguslie ballers.
1 twelve head spooling machine.

Bobbin Shop :—

1 circular saw.
2 double blocking machines.
1 ringing machine.
8 finishing lathes.
1 glazing barrel.
1 grindstone.

Mechanics' Shop :—

1 planing machine.
1 double geared drill.
1 slotting machine.
1 12-inch lathe, 22-feet bed.
1 wheel cutter.
1 wall engine.

Other plans are given farther on.

Productions and Speeds.

In the case of the slow traverse doubling drum winder the speed depends upon the ability of the operatives, the quality of the single yarn, the counts of the yarn, the general condition of the machine. A modern machine will stand almost any speed the yarn and the operatives can manage with, but driving pulleys of 12-inch diameter × $3\frac{1}{4}$-inch width may take about 200 r.p.m., giving a winding speed of about 200 yards per minute, since a drum 12-inch diameter equals 1 yard circumference approximately. 120 bobbins may require $1\frac{1}{2}$ to 2 horse power, and one girl may attend from 20 to 30 spindles either on the above frame or on the quick traverse double drum winder.

In some quick traverse drum winders the traverse is maintained at a constant rate of speed, but the drum and winding-on speeds are varied by a change wheel to suit the character of yarn which is just then being wound.

A doubled yarn, for example, wants a higher proportionate rate of traverse than does a single yarn to the amount wound on. Each side of drums in this case may have its speed separately changed.

This double drum, quick traverse winder, may require two horse power per 120 drums, the driving pulley of 12 inches diameter running at possibly 280 r.p.m.

Soft cheeses may be made for dyeing purposes, the traverse rate being suited to this requirement. Yarn may be drum wound on cones of varying diameter and pitch of cone. Yarn may be wound on cones or paper tubes from hanks, on conical tubes from cops, on parallel tubes of paper from cops, on parallel wood tubes from cops or ring-frame bobbins.

The single end *split drum* winder differs radically in its traverse arrangements from any other type of winder. The absence of external cams and traverse rods makes this machine very quiet, and enables very high speeds of winding on to be used if desired as in the case of using bottle bobbins, and vertical burners on some kinds of gassing or singeing frames. Automatic thread picking up devices are in use on these split drum single end winders running at high speeds.

In actual practice the winding-on speed is not limited by the traverse or other mechanical parts, but by the speed the yarn will stand; more usually between the limits of 500 and 900 feet per minute, which is very much higher than winding frames used to run at.

The horse power is approximately represented by one per 50 drums of 9 inches diameter.

Driving pulleys of 12 inches diameter making from 290 to 390 r.p.m.

The vertical spindle single end winder contains some very different mechanical arrangements and principles of winding on, from the drum winder.

The spindle winder has a varying rate of winding-on speed, while the drum winder ordinarily gives a varying pitch of spiral wind. One attendant may mind from 30 to 40 spindles and one horse power may serve for as many as 300 spindles. Cops or bobbins may be unwound on this machine either from the side or over the end, but side unwinding from ring bobbins or unwinding from hanks may only require a front spindle speed of 600 r.p.m., as against 900 for end unwinding from cops or ring bobbins, spindle wharves $1\frac{1}{8}$-inch diameter front row, $1\frac{1}{2}$-inch back row, the latter spindles making proportionately fewer revolutions per minute.

Productions may reach about 6 hanks per hour for endways unwinding, $4\frac{1}{4}$ hanks for side unwinding, and 4 hanks for unwinding from reeled hanks.

In the case of reels the diameters of driving pulleys may be 7 inches, possibly reaching up to 150 r.p.m. for single cop reels and up to 250 r.p.m. for double reels.

It is the custom to drive a pulley of about 6-inch diameter on

the reel axis from a 14-inch on the pulley shaft. Eight double 40 hank reels or 16 single 40 hank reels may require one horse power.

One modern bundling press with double cams for the lifting ram may require one horse power, the driving pulleys being 24 inches × 3 inches and making 60 r.p.m.

Production possibly 9,000 lb. per week of 48 hours or at that rate.

In a yarn preparing machine the driving pulleys of 22 inches diameter might have a speed of 80 r.p.m. and the machine require from $\frac{3}{4}$ to 1 horse power.

Common dimensions of pulley for a beam warping machine are 15 inches diameter × 2 inches width, making from 40 to 50 r.p.m., the horse power per machine being $\frac{1}{3}$ to $\frac{1}{2}$. One beam warper may serve from 60 to 80 looms.

Gallows or Guide Pulley.

Messrs. Platt Bros. show diagrams as per Fig. 63, but they make the same of various patterns to suit conditions for either strap or rope, and with hand wheel and screw tightening arrangement.

The most productive gassing frame is supposed to be the vertical burner, with drums containing automatic thread picking-up devices on the split drum principle, and using bottle-shaped bobbins in the creel. Such frames are reckoned to give productions three to four times greater than the ordinary gassing frames containing brass or aluminium grooved yarn bowls; the drums attaining a speed of 600 or more r.p.m. and the hanks $4\frac{1}{4}$ per light per hour for every 100 revolutions of the drums.

Driving pulleys 12 inches diameter × $2\frac{1}{2}$ inches width, making up to 500 r.p.m. or more.

Flyer Doubling Frames.

$3\frac{1}{2}$-inch	gauge,	$3\frac{1}{2}$-inch	lift,	spindle	speed	3,500	=	55	spindles	per	h.p.
4	,,	,,	4	,,	,,	,,	,,	3,200	=	45	,,	,,	,,
$4\frac{1}{2}$	,,	,,	$4\frac{1}{2}$	,,	,,	,,	,,	2,800	=	40	,,	,,	,,
5	,,	,,	5	,,	,,	,,	,,	2,300	=	30	,,	,,	,,
6	,,	,,	6	,,	,,	,,	,,	1,800	=	25	,,	,,	,,

Ring Doubling Frames.

$1\frac{1}{2}$-inch	rings,	spindle	speed	8,000	to	9,000;	70	to	80	spindles	per	h.p.
$1\frac{3}{4}$	,,	,,	,,	,,	7,000	,,	8,000;	60	,,	70	,,	,,	,,
2	,,	,,	,,	,,	6,000	,,	7,000;	50	,,	60	,,	,,	,,
$2\frac{1}{4}$	,,	,,	,,	,,	5,000	,,	6,000;	45	,,	50	,,	,,	,,
$2\frac{1}{2}$	,,	,,	,,	,,	4,000	,,	5,000;	40	,,	45	,,	,,	,,

Mill Planning.

Formerly the question of counts to be spun would have been the one great deciding factor as to locality of a large new cotton spinning mill, but recent developments have modified this point very considerably. Until the last few years a projected medium fine spinning mill would almost certainly have been expected to locate in the

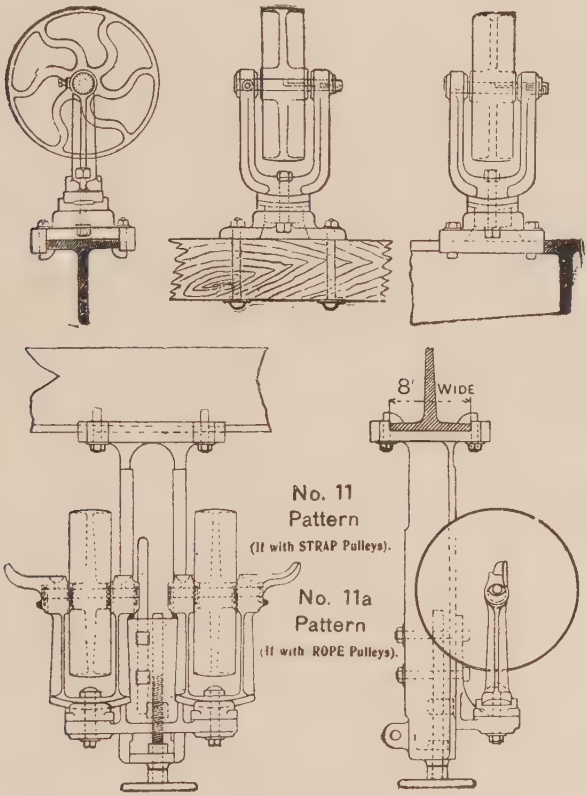

FIG. 63 (Platt Bros).

Bolton district. This now appears to be a matter of comparative indifference since more such mills have been put up since 1895 in the Oldham, Shaw, Middleton, Ashton, and Preston districts than in Bolton. Nevertheless, it is better to build a mill in a district where specially-trained operatives are available, other circumstances being equal. Naturally it is also best to build as near as convenient to

a railway station, although many new spinning mills are quite a distance therefrom. These, however, in Lancashire, will be found not to suffer much thereby, because they are located inside the carting area of the town, and get their goods mostly carted at much the same rates as mills nearer the station. In the Lancashire cotton spinning districts it is seldom difficult to transport such articles as cotton, coal, yarn, stores, and machinery, nor is it difficult to get to and from the two principal markets—Manchester and Liverpool. Since cotton works better in a warm moist atmosphere it is all the better if the mill be built in a position sheltered upon the north and east sides, and it is all the better if it be adjacent to a good river or canal. A decent supply of water is, of course, essential, either from one source or another, and regard must be paid to this point in fixing the site. Unless the available land is also reasonable in price there will, of course, be an extra charge on the capital in this respect. Good roads for the purpose of carting and for operatives are of course advisable. The foundation requires to be thoroughly solid, as the weight of a modern cotton mill filled with machinery is something enormous. A stiff solid clay foundation is considered extremely good, as it affords a good basis for the building, and also will help to retain the rain in the near vicinity ready for evaporation in dryer periods.

CHAPTER X.

CALCULATIONS, NOTES ON DOUBLING, DOUBLING MILL SYSTEMS.

Resultant Counts. Average Counts.

When two or more yarns of the same or different counts are doubled and twisted together the final counts of the produced doubled yarn represents the *resultant counts.*

Example.—Three single yarns of 60's counts are twisted into a three-cord.

60 ÷ 3 = 20's resultant counts without allowing for twist contraction.

About 62's single yarn might be needed to get full 60's/3, this being dependent upon the twist constant in use.

It is obvious if three threads of equal counts, weight, and length are put together, the combined or resultant counts will be three times as heavy.

Average Counts is a different thing from resultant counts, and will be obtained when a doubling mill uses certain weights of different counts of single yarn, or when different counts of yarn are laid side by side in a coloured warp for the loom.

Example.—The consumption of single yarn in one week in a certain doubling mill equals the following:—

2,000 lb. of 80's single
1,000 ,, ,, 70's ,,
1,500 ,, ,, 60's ,,
3,000 ,, ,, 40's ,,

What are the average counts of single yarn?

Weight.		*Counts.*		*Hanks.*
2,000	×	80's	=	160,000
1,000	×	70's	=	70,000
1,500	×	60's	=	90,000
3,000	×	40's	=	120,000
7,500 lb.				440,000

440,000 ÷ 7,500 = 58·6̇ average counts.

Using a higher proportion of the coarser counts would, of course, lower the average counts.

Mixed Doublings.

In the production of fancy yarns, and occasionally besides, different counts of yarns are twisted together and a special rule is needed to determine the resultant count.

Example.—A single yarn of 30's is twisted with a single yarn of 60's.

Rule 1.—Divide their product by their sum—

$$\frac{30 \times 60}{30 + 60} = \frac{1800}{90} = 20\text{'s resultant.}$$

If there were three or more single yarns twisted together in this manner we could apply the foregoing rule to any two: then apply the rule again to first answer and remaining single number.

Example.—Single yarns 30's, 60's, and 70's are twisted together. Find resultant counts.

(*a*) 30's with 60's give 20's as above.

Then (*b*) 20's and 70's

$$= \frac{20 \times 70}{20 + 70} = \frac{1400}{90} = 15\cdot\dot{5}.$$

Final answer without contraction allowance.

Reasoning.—Find resultant counts when 10's and 20's single yarns are put together in one thread:—

$$\frac{10 \times 20}{10 + 20} = \frac{200}{30} = 6\cdot\dot{6}.$$

In length 10 lb. of 20's would equal 20 lb. of 10's, and in each case we should have $10 \times 20 = 200$ hanks. Place together 200 hanks of each and we get 30 lb. = 200 hanks.

Let Q represent the result of doubling 20's and 10's singles together.

Since $Q\ (20 + 10)$
$= 20\text{'s} \times 10 \text{ or } 10\text{'s} \times 20$ we get

$$Q = \frac{10 \times 20}{10 + 20} = 6\cdot\dot{6}.$$

There are other methods of obtaining resultant when twisting mixed yarns together.

Sometimes the position is reversed, and in the case of fancy yarns we may ask, What counts of unknown single yarn will be wanted to go with an already determined single to produce a specified resultant?

Example.—What other counts of single yarn must be doubled with a 36's to produce a 20's two-fold?

Rule.—Divide their product by their difference.

$$\frac{36 \times 20}{36 - 20} = \frac{720}{16} = 45\text{'s.} \quad \text{Ans.}$$

Alternative rule for resultant counts when two or more single threads are put together.

Rule.—Take 1 lb. of the finest counts, and the weight of an equivalent length of each other counts. Divide the total weight into the hanks of doubled thread.

Example.—30's, 40's, and 50's are doubled together. Find resultant counts.

50 hanks of 50's = 1 lb. = 1·000
50 ,, ,, 40's = $1\frac{1}{4}$,, = 1·2500
50 ,, ,, 30's = $1\frac{2}{3}$,, = 1·6666
4·9166 lb.

Fifty hanks of the doubled yarn weigh 4·9166 lb. By the rule that hanks ÷ lb. equal counts we get

$$50 \div 4{\cdot}9166 = 10{\cdot}17 \text{ counts.}$$

It is obvious almost any kind of unequal counts doubling could be solved by above method. A gearing calculation is given in a previous Chapter.

Textiles other than Cotton.

In cotton, the term counts represents a certain length of yarn per lb. weight, as, for example, 10's and 20's respectively mean 10 and 20 hanks per lb.

Terms and standards are different for other textiles, as, for example, there are: "counts," "run," "skeins," "spindle" and "cuts."

Matters would be simplified by adopting for all the leading textiles common standards of length and weight. For example, 800, 900, or 1,000 yards might be termed a unit hank in every case, and number of units per lb. would be the counts.

A unit of 100 or 1,000 would simplify any reckonings.

Fancy yarns might be all of one textile, such as silk, cotton, or wool, or might be a mixture of two or three materials.

In cotton and silk 840 yards weighing 1 lb. = 1's counts.
In worsted 560 ,, ,, ,, = 1's ,,

Any mixtures of these in fancy threads would need one material converting to terms of the other for practical and business purposes.

Example.—What is the worsted equivalent of 30's cotton counts?

$$\frac{30 \times 840}{560} = 45\text{'s}$$

or 30's cotton counts = 45's worsted counts.

In such fancy doubled yarns as loop yarn, snarl yarn, corkscrew yarn and others, it is difficult to calculate exact resultant counts owing to variations in twisting, looping, and corkscrewing contraction.

Fancy Yarn Doubling.

A fancy yarn doubling machine properly constructed may contain cone-speed pulleys so that the spindles may be quickly altered in speed over a wide range to suit any twist per inch, any number of doublings, and any counts of yarn. Also the different lines of rollers may be readily altered in relative speeds, and in number used, while the threads may be guided along various paths as required, from creels to rollers and spindles.

Such a machine may be readily set out to make any one of various kinds of fancy doubled yarns.

In twisting mixed yarns the first essential is to reduce to terms of one material.

Example.—Assume now we have a good quantity of 2/36's cotton = 18's doubled, and we desire to double two ends of this 18's cotton along with one end of 26's worsted, to produce a loop yarn. The single 26's worsted is delivered at twice the rate of the 2/36's cotton to produce the loop effect. Find the resultant counts of loop yarn allowing nothing for contraction by twist, and working on the basis of worsted counts.

(*a*) $\frac{18 \times 840}{560} = 27\text{'s worsted} = 18\text{'s cotton.}$

(*b*) Two of these 27's are put together giving $\frac{27}{2} = 13\frac{1}{2}$'s, or 9's if kept in cotton counts.

(*c*) Because a double length of 26's worsted is used we may take this at $\frac{26}{2} = 13$'s.

(*d*) We reach the final question. What is the resultant of twisting together a $13\frac{1}{2}$'s and a 13's?

$$\frac{13{\cdot}5 \times 13}{13{\cdot}5 + 13} = 6{\cdot}62\text{'s worsted counts.}$$

Gearing Details. Ring Doubler.

Spindle Speeds.—

8,000 to 9,000 r.p.m.	$1\frac{1}{2}$	-inch	range	70/80	spls.	per h.p.
7,000 to 8,000 ,,	$1\frac{3}{4}$	,,	,,	60/70	,,	,,
6,000 to 7,000 ,,	2	,,	,,	50/60	,,	,,
5,000 to 6,000 ,,	$2\frac{1}{4}$	,,	,,	45/50	,,	,,
4,000 to 5,000 ,,	$2\frac{1}{2}$	,,	,,	40/45	,,	,,

For straight lift doubling frames—the more usual sort—the only ordinary change wheels are for twist, of which a very full range is easily kept since top and bottom twist wheels may be interchangeable.

For cop build on doubling frames—preferred in some cases—ratchet or shaper wheels are required as well as twist wheels, but of course there are no draft wheels as for ring spinning.

Five twist wheels and three ratchet wheels may be given with a new frame and others purchased.

The statement for a full twist per inch calculation may be given as below:—

$$\frac{\text{Front roller wheel} \times \text{top stud wh.} \times \text{bottom twist carrier} \times \text{dia. of tin roller}}{\text{Top twist wheel} \times \text{Twist wheel} \times \text{tin roller wheel} \times \text{dia. of spl. wharve} \times \text{circum. of front roller}} = \text{Twist per inch.}$$

Ring Doubling Frames. Production Calculations.

The production on doubling frames varies considerably owing to many circumstances which enter into the production of doubled yarns.

Assume the more usual twist constant 4.

Thus 16's/4-fold is practically equal to 4's counts, and the turns per inch will be the square root of 4 (viz. 2) multiplied by 4 which equals 8.

$$\frac{\text{Speed of front roller} \times \text{circumference} \times \text{minutes}}{\text{inches in hank (30,240)} \times \text{counts}} = \text{production in pounds (lb.).}$$

Deduct percentage for stoppage.

Hanks ÷ lb. = counts.

Hanks ÷ counts = lb.

Lb. × counts = hanks.

$$\frac{\text{Speed of spindles}}{\text{turns per inch} \times \text{dia. front bottom roller} \times 3{\cdot}14} = \text{revs. of front bottom roller.}$$

To find the counts resulting from *doubling unequal counts* together, say 32's single with 16's single: Multiply counts together and divide by their sum, thus

$$\frac{32 \times 16}{32 + 16} = \frac{512}{48} = 10{\cdot}7.$$

One firm of machinists advertise as below:—

"*Makers of Looms* for weaving every description of light, medium, and heavy goods, plain or fancy, cotton, silk, linen, and cocoanut fibre.

"*Sizing Machines* from new patterns, of any width, number, or size of cylinders, and with the latest improvements, including patent ball bearings to cylinders, patent presser motion, etc.

"*Warping Machines* on either the falling-rod or stop-motion principle.

"*Winding Machines* to wind from cops, hanks, or throstle bobbins, on to warpers' bobbins, or from hanks on to pirns for the shuttle; also drum winding, single or double. Also to wind from ring frame bobbins.

"*Dobbies and Treading Motions* of various kinds, positive and non-positive, dhootie motions, handkerchief motions, selvedge motions, sateen motions, folding and measuring machines, cloth presses, looming frames, drawing-in frames, beam-flanging frames, beam racks, etc."

Doubling Principles.

A doubler may produce very different effects by inserting either the same or opposite twists, either in first or second doubling; or by very greatly varying the amount of twist, by folding and twisting only two or several single threads together, by the doubling together of doubled threads or cabling, by twisting together threads which differ in respect of counts, colour or twist. It is a very easy matter to twist together threads of different colour so as to produce a grandrelle thread of two or three-folds of different colours.

Twist per inch may vary all the way from XX hard to XXXX soft, the former taking about six constant, and the latter as little as 1·3 as the constant multiplier into the square root of counts doubled.

As stated, novelty yarns of many descriptions are produced by the aid of specially constructed fancy yarn doublers, which give great facilities for speed variation and for conducting the component threads around the rollers. Some effects also by applying special motions to plain doublers.

Some Uses of Doubled Yarns.

Hosiery yarns for various branches of the knitting trade, yarns for the refined lace trades, doubled yarns for many kinds of woven fabrics, yarns for the tremendously great sewing thread business, also for crochet work. On the heavier side we have folded yarns for sail cloth, balata duck, elevator belts, other belting.

Many folded yarns for such purposes as fish nets and for loom healds, such finished yarns requiring to be very strong and durable.

Other effects are represented by cabled yarns for motor fabrics, folded yarns, folded motor duck.

Medium yarns may be required for such goods as Venetians, velvets, poplin, and gaberdine. Fustians and cotton trouserings afford a use for two-fold cotton yarns. Much two-fold cotton yarn goes Bradford way for use in the warps of union goods.

Crepe-de-chene and voiles represent two-folds in higher counts, say 80's to 100's twofold, but 50's single yarn having 100's turns per inch, when "mock voile" has been required.

Lace may take still finer ranging from 90's to 200's in the single and from this made into two-folds.

Nottingham is the chief customer for lace yarns in England with some amount in other districts. Cabling and high doublings are not required for the lace trade, which at the time of writing is suffering under a severe trade depression. Both the ring and flyer doublers are in vogue for the lace trade, preceded by cop winding either by slow or quick traverse. Afterwards clearing and probably putting the yarn in the form of bottle bobbins for end unwinding at the next process, which is the gassing frame. Sometimes prepared, reeled, and made up into 5 lb. or 10 lb. bundles.

The lace trade requires brass bobbin or weft yarn, ground warp yarn.

The gimp thread and outline thread. The predominating weft and ground warp are usually fine two-folds gassed. Partly to get the flat concentrated effect the weft for the brass bobbins is also put through the heavy calendering rollers of the preparing machine.

About 2/40's ungassed, American cotton often twiner doubled, is sometimes used for the outline threads, but 2/80's is used in some other cases.

The brass bobbin weft is subject to much strain in working. Bobbin net or lace machines were well described and illustrated by Dr. Ure as far back as about 1836.

The more standard lace yarn is a Bolton product ranging mostly from 2/80's to 2/200's, but trade has often been done in singles of half above counts spun reverse way to imitate the usual doubling direction, and naturally being much cheaper although much inferior.

Supercarded yarns of 60's/2 are sometimes asked for, but the

lace trade reaches up to finest counts spun, 240's/2 to 380's/2 from best combed sea islands. Combed Egyptian is in great demand for good qualities of lace—but not the very finest.

In Bolton and other mills the author has found the flyer twisting frame much used for producing two-folds for the lace trade, especially in the finer and better qualities. Its low production is not a great fault in these yarns, but in the lower ranges of counts the ring doubler has usurped the flyer. For the brass bobbin weft in the lace trade, the lace manufacturer may put the yarn upon brass bobbins about $\frac{1}{16}$-inch traverse and possibly 3-inch diameter.

There is a varying demand for double spun yarns of 60's counts or so, in which a single spun yarn has extra twist added to it in the same direction on the wet doubling frame.

The use of casement cloth for window curtains, alterations in fashions for women's blouses, and the trade depression hit the lace trade badly at times. The year 1921 was a bad one in this respect, also 1922.

Doublers may produce very many effects by varying the amount of twist, the direction of twist, the number of threads put together, the use of water or otherwise, by the singeing process, by cabling, by flattening and polishing the yarn in the preparing machine, by using different colours of component threads, or different counts and qualities of single yarns, by using mercerised or plain yarns. The doubling machine is also the chief one for producing novelty effects in yarns.

Traveller Changing.

One method is for an operative to bring each traveller in turn to the front of the ring, by the left hand, and using a bobbin in the right hand to force the traveller off, and allow same to fall into the left hand.

To apply new travellers on doubling frames, a girl may hold the travellers in the left hand, and suspend one traveller over the top curve of the ring. A second girl may force the traveller on its ring by means of a bobbin or other convenient article.

Two competent girls may fit up a frame of full length with new travellers in less than five minutes. Heavy strong travellers require more time and effort than weaker ones.

Hard twisted threads will stand heavier travellers, and this is an excellent thing to reduce twist contraction.

Possible Equipment.

1. 1 Single cop vertical spindle winding frame for warpers' bobbins, $4\frac{1}{2}$-inch gauge, 324 spindles.
2. 11 drum winding frames, 120 drums, 5-inch traverse.

3. 9 vertical spindle clearing frames for doubled yarn, 300 spindles, 4½-inch gauge. To make either warpers' bobbins or bottle bobbins as required, or some frames only fitted with bottling motion.

4. 6 gassing frames to work either from bottle bobbins or other sort, and to make cheeses of gassed yarn 3 inches wide.

5. 24 double, 40 hank reels, 3½-inch space.

6. 3 circular warping mills, accompanied by 3 chain warping machines.

7. 6 single preparing machines.

8. 2 bundling presses.

32 to 36 feet is considered a convenient working length of doubling frame. With good conditions a skilful operative will attend to 600 spindles, i.e. four sides of 150 spindles each, or two full frames of 300 spindles each. One creel bobbin per spindle. Two alleys are better than two complete frames for an attendant. Excessive work on driving ends of tin rollers and on the copping motion cams, is an objection to very long frames.

Second Plant for the Lace Trade.—Ring doubling mill to produce 5,000 lb. of fine gassed yarns, 100's to 200's two-fold, per week of 48 hours. Preparing and bundling.

1. 9 Hill and Brown, split drum winding frames.

2. 65 ring doublers, 364 spindles each, 2¼-inch gauge, 1½-inch and 1¼-inch ring, 4-inch lift.

3. 10 Hill and Brown cross winding and clearing frames, 100 drums, 5-inch traverse.

4. 10 gassing frames, 150 lights, 5½-inch gauge.

5. 30 double 40 hank reels, 3½-inch gauge.

6. 26 yarn preparing machines.

7. 3 10 lb. bundling machines.

Third Plant, for Sewing Cotton.—

1. 23 doublers, 380 spindles, each 2½-inch gauge.

2. 7 doublers, 344 spindles, each 2¾-inch gauge.

3. 3 doublers, 316 spindles, each 3-inch gauge.

4. 3 patent winders, 120 bobbins, 4½-inch traverse.

5. 1 vertical spindle, clearer winding frame, with bottle bobbin motion.

6. 6 double 40 hank reels.

7. 2 hank winders, 70 drums, 5-inch traverse.

8. 18 bobbin to bobbin polishers.

Above plant calculated to produce about 5,000 lb. weight of thread in a week of 48 hours, average 36's/3-fold.

N.B.—Above represents the machinery in the doubling section only. Cases exist where the same have the spinning plant to produce the single yarns. Also the plant for dyeing the sewing

cotton to any required colour, and afterwards for spooling and balling the thread for the market.

A mechanic's shop would form part of the general equipment,

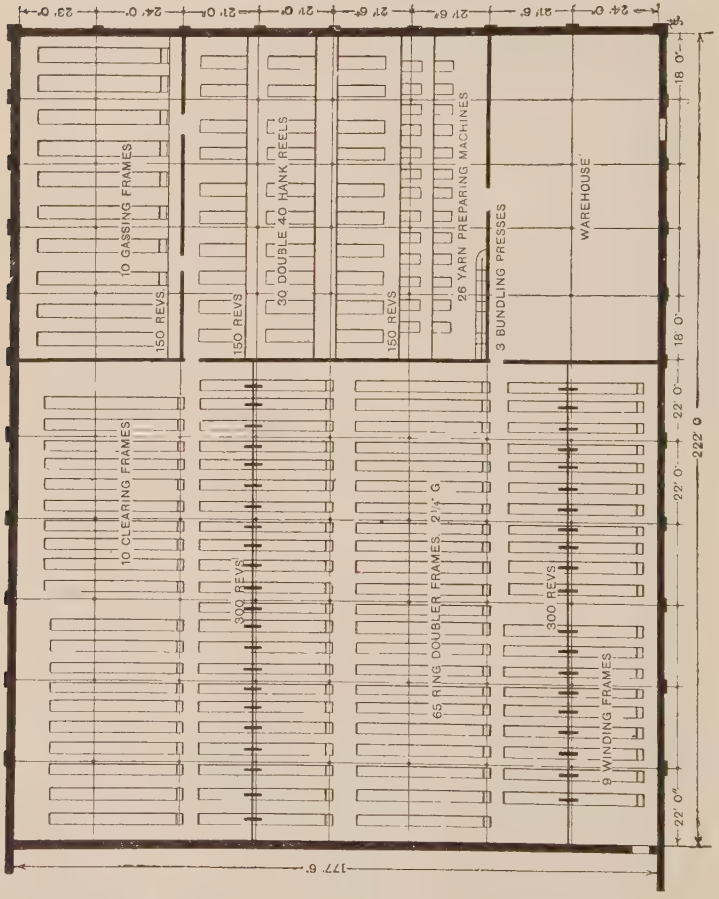

FIG. 64.

and sometimes the same firm will also have plant for making their own empty spools.

Schemes of Work.

Method 1. *For Warps.*—Starting with the twist way single yarn 2 or 3 ends are wound together on a quick traverse frame.

For two and three-fold twisting is next done weft way at either twiner or ring doubler.

The third operation is to wind the two or three-fold yarn upon warpers' bobbins at the vertical spindle winder, or clearing frame, although in some cases the quick traverse frame is used. In clearing the yarn should be freed from both ends and lumps. Two or three-fold warp yarn may be used either "plain" or "gassed," and if for gassing the clearing frame should make bottle-shaped bobbins. If for "plain" the warpers' bobbins are placed in the creel of the warping machine. The beam warper is used for grey warps.

The warping mill and chaining machine may be used if the yarn is to be bleached and dyed, instead of using the beam warper.

If the two or three-fold yarn is for export it may be wound upon small paper tubes at the quick traverse winding frame.

Method 2.—Two and three-fold bundle yarn.

1. Quick traverse doubling winder.
2. If the single is weft way the doubler now puts twist in twist way, with twist constant to suit customer.
3. Twisted two or three-fold reeled into hanks.
4. Treated in preparing machine.
5. Knotted 5, 10 or 20 hanks together, and either hard pressed in bundling machine, or made soft pressed long bundles.

Method 3. *Three-cord Sewings.*—

1. The single yarn is twist way, and may be preferably wound single end at the winding frame to get some degree of clearing and to obtain a long length of yarn either upon a warper's bobbin or a quick traverse cheese.
2. 3 bobbins or cheeses to each spindle at the ring doubler.
3. Wound upon bobbins suitable either for warping or reeling as required, and having regard to immediately possible subsequent processes such as dyeing.

Method 4. *Four-cord Sewings.*—

1. Doubling weft cops of large size, but twist way twist are wound in pairs at the doubling winder.
2. Twisted same way as spun in P.P.G. process.
3. The two-fold yarn is cleared and wound upon larger bobbins for the finishing doubler.
4. Twisted weft way in finisher doubler.
5. The thread may now be wound on bobbins suitable for the warping mill if intended for mill and chain warping preparatory to dyeing. If for reeling the cheeses or bobbins will be suitable therefor.

N.B.—It will be noted that the four-cord sewing thread is twist way, twist way, weft way in the single, first doubling and second doubling respectively, and six-cord sewings would follow

much the same series, but with three two-cords put together instead of only two. It would be cheaper, but not as good, to make three-cords and then twist two of these together to get six-cord.

Method 5. Crochet Yarn.—Four-fold and six-fold crochet yarns follow much the same processes as the sewings, but differ in the direction and amount of twist.

For crochet yarns the twist directions are: (*a*) Single yarn twist way. (*b*) Preparing weft way, finishing twist way.

We thus have in cabled sewings T.T.W.

and in cabled crochet T.W.T.

when T = twist way and W = weft way.

For four-fold sewings P.P.G. twist may $\sqrt{\text{counts}}$ doubled × 4, and for finishing 3·8, but practice differs considerably with different people. P.P.G. for crochet yarns is weft way so that rather more twist may be put in the single yarn for crochet yarns than for sewings, in which twist upon twist may be bad for individual cotton fibres in strength.

For finishing crochet yarns the twist constant may be 2·8.

Roller Laps.—Broken ends lapping round the rollers, broken threads entangling with adjacent threads, are causes of roller laps, and roller laps represent the chief source of doubler waste. Single roller stop-motions or four-fold preventers have been satisfactorily adopted in some cases. In some firms the system has been adopted of having little girls looking out for roller laps or broken threads, and promptly lifting up the short top rollers, and also taking the corresponding bobbin off its spindle and placing on the rail ready for the doubler. Modern four-fold preventer appliances are reasonably effective.

Broken ends and roller laps may be reduced in number by having correct speeds of spindles and rollers. In cases of much changing of counts and twists per inch, best speeds for each sort may be obtained by having speed driving cones, or by using rim-pulley driving.

Possible Strength Tests for Six-cord Sewings. Half-lea or 40 Threads of 1½ Yards Each.

For	40's	six-cord	sewings	half-lea	=	270	lb. or	6·75	lb.	per thread.
,,	50's	,,	,,	,,	=	230	,, ,,	5·75	,,	,, ,,
,,	60's	,,	,,	,,	=	214	,, ,,	5·35	,,	,, ,,
,,	70's	,,	,,	,,	=	200	,, ,,	5·00	,,	,, ,,
,,	80's	,,	,,	,,	=	160	,, ,,	4·00	,,	,, ,,
,,	90's	,,	,,	,,	=	146	,, ,,	3·65	,,	,, ,,
,,	100's	,,	,,	,,	=	130	,, ,,	3·25	,,	,, ,,
,,	120's	,,	,,	,,	=	105	,, ,,	2·625	,,	,, ,,

Copping Motion for Straight Lift Motion on Ring Doublers.

Although rather more complicated the cop-shaping motion is deemed better than the straight lift for long lifts. The amount of ballooning appears to be less with the cop-shaping motion, the yarn can be wound over the nose of bobbin, there is no chance of yarn lumps or nicking-in at the bottom of the bobbin.

In some cases the roving frame shape of bobbin is produced, with straight but ever shortening lifter traverse, and equal cones at both ends of bobbin.

Spindle Details.

A complete modern ring-doubler spindle may include: (1) main bearing or spindle holder; (2) a loose inner tube; (3) a lever-hook to keep spindle down; (4) the warve; (5) possibly a knee brake.

To Reduce Metres per Kilogramme to Yards per Pound, and Thence to Obtain the Counts of Yarn (English).

Rule.—Divide the number of metres per kilogramme by 2·015, or, approximately, by 2, and the quotient will be the number of yards per lb., which, divided by 840, gives the English counts of yarn.

Example.—80,000 metres per kilogramme, or 40's French counts.

$\frac{80{,}000}{2}$ = 40,000 yards per lb. And $\frac{40{,}000}{840}$ = 47·6 counts English.

French Yarn Table.

The French system of numbering is based on the metric system (one metre = 39·37 inches), which is the unit of length, and the kilogramme (one kilogramme = 2·2047 lb.), which is the unit of weight; in numbering yarn accordingly, a thread of cotton yarn 1,000 metres long, weighing 500 grammes (half a kilogramme) is termed No. 1.

No.	2's =	2,000	metres	weighing	500	grammes.
,,	3's =	3,000	,,	,,	500	,,
,,	4's =	4,000	,,	,,	500	,,
,,	30's =	30,000	,,	,,	500	,, and so on.

A length of 1,000 metres is termed a hank (or *écheveau*), and each hank is divided into 10 skeins (*échevettes*) of 100 metres each. These skeins are wrapped on a reel having a circumference of 1·425 metres, making 70 revolutions to the skein.

It follows from the above that the count indicates the number of hanks required to weigh 500 grammes.

Rule.—Divide the metres reeled by twice the weight in grammes to obtain the counts (French).

To convert French counts to English, multiply the French yarn number by 1·18 = the English counts required.

To reduce English counts to French, divide the English counts by 1·18 = the French counts required.

Upright Spindle Winding Frame Calculation (Bolton Technical School).

Motor r.p.m., 940. Motor pulley, $3\frac{1}{2}$ inches.
Machine fast and loose pulleys, 20-inch diameter.
Tin roller wheel, 40 teeth.
Carrier wheel, 50 teeth.
Driven wheel, 110 teeth.
Mangle wheel pinion, 8 teeth.
Mangle wheel, 128 teeth.
Change wheel on same shaft, 23 teeth.
Lifter wheel, 56 teeth.
Tin roller diameter, 5 inches.
Spindle wharve front row, 1 inch.
,, ,, back ,, $1\frac{1}{4}$ inch.

These particulars work out to ($164\frac{1}{2}$ r.p.m. of tin rollers, 658 for $1\frac{1}{4}$ inch spindle wharve, and about $16\frac{1}{2}$ inches per minute of lifter traverse.

Drum Winding Frame (Bolton Technical School).

r.p.m. of motor, 940. Motor pulley, 4-inch diameter.
Fast and loose pulleys on frame, 10 inches.
A 21 wheel on drum shaft drives an 80 on cam shaft.
Diameter of bobbin drum, 3 inches.
Lift or traverse equals 5 inches.

1. $\frac{940 \times 4}{10} = 376$ r.p.m. of drums.

2. $376 \times \frac{21}{80} = 98{\cdot}7$ double strokes of traverse per minute.

3. $98{\cdot}7 \times 10 = 987$ inches per minute of traverse or lift.

4. $3 \times \frac{22}{7} \times 376 = 3{,}545$ inches per minute.

Surface speed of drums; which equals winding speed of yarn when there is no slippage.

Metre Indicators for Frames.

More usually production indicators for roving frames, ring-frames or ring doublers, may register hanks in England.

Mule indicators may register either hanks or draws as required.

The metre is the standard of length for the metric system adopted in some countries and indicators may be adapted to this basis.

The metre equals 39·37 inches or somewhat over 1 yard in length. A centimetre equals $\frac{1}{100}$ of a metre. A kilometre equals 1,000 metres.

Where a frame indicator for hanks may register up to 100 hanks per spindle, a metre indicator may register up 100,000 metres, or 99,999 and then 00,000 represents 100,000.

If an English indicator registered 40 hanks, the metre equivalent would be :—

(*a*) $40 \times 840 = 33{,}600$ yards.

(*b*) $\frac{33{,}600 \times 36}{39{\cdot}37} = 30{,}723$ metres.

The metric indicator would show 30,723 metres instead of 40 hanks. A hank equals about 768 metres.

A hank indicator may show 99 hanks and then register 00·00 which represents 100·00 hanks and is followed by 01·00 equals 1 hank.

CHAPTER XI.

PREPARING AND POLISHING.

Preparing Process for Cotton Yarn.

"PREPARING" is limited to certain classes of yarns for special purposes, the chief purpose being for lace yarns which are required to be as thin as the required strength per lea will permit.

Preparing is really a heavy calendering process performed on the yarn in hank form by heavily weighted calender bowls for periods of possibly 3 or 4 minutes, $2\frac{1}{2}$ to $3\frac{1}{2}$ minutes for two-fold lace yarns being sometimes the custom.

Two definite effects are produced on the calendered yarn.

(*a*) The roundness of yarn is diminished, and it is condensed and flattened by the heavy compression.

(*b*) The calendering imparts a lustrous or polished appearance to the yarn, sometimes intensified by applying some kind of polishing mixture.

Necessarily, a preparing machine resembles a bundling machine in that the framing and most of the details are of very strong construction.

A preparing machine is of the nature of a power-driven mangling machine in its action and effect on the hanks of yarn.

A standard preparing machine by any maker contains three revolving calenders or bowls placed one above the other, with the hanks of yarn passing round the middle roller and then outwards around a carrier bowl. Heavily weighted compound levers apply the pressure to the rollers and yarn.

Possibly twenty hanks of fine two-fold lace yarn may be treated at one time, the reel having succeeded the twisting frame in putting the yarn into proper condition.

An exceptionally strong framework is built on a heavy bed plate. All attached surfaces are planed or milled and different parts made interchangeable.

The top roller may be made of cast-iron, highly polished, and the other two rollers or bowls made of steel, with centres of compressed cotton. In a calender bowl works it is quite possible now to find machines for breaking up cop bottom or other hard waste.

and afterwards to make calender bowls of compressed cotton for various purposes.

A preparing machine may require $\frac{3}{4}$ h.p. and have a roller speed of 80 r.p.m.; pulleys 3 × 22 inches.

The hanks from the centre roller are kept in tension by an iron carrier or extension roller. The middle or yarn roller is carried on a swinging shaft, to permit of its being swung out of contact with the top and bottom rollers to allow the insertion or withdrawal of

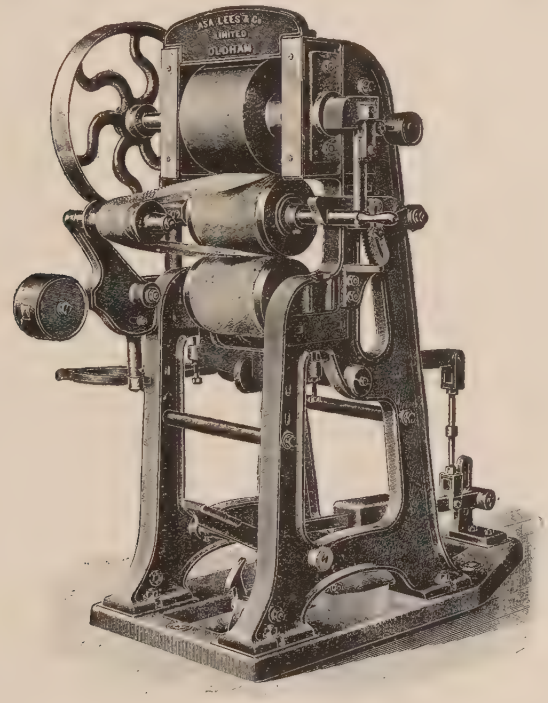

Fig. 65.

the hanks of yarn. This central roller is held in position during working by a catch connected with the knocking-off motion. The knocking-off can be adjusted to take place after any required time or amount of yarn treatment, its duty being to release the sustaining catch of the middle roller, when the latter swings out of contact with the other two rollers and also permits ready changing of hanks, the hanks being now eased on the tension roller. It is customary to apply the driving pulleys to the top roller, and to

apply the pressure or weight to the bottom roller. The bottom *gearing* roller is carried in a strong slide or frame, and is brought into action by a foot lever, the necessary pressure being put on the rollers by means of a weighted lever.

Twelve-inch diameter for top roller and 9-inch for each of the others, are dimensions given by one maker. Bottom roller in vertical slides and held up by weight, middle roller capable of swinging open like a gate or door, top roller receiving the power drive, are distinctive features.

The principal fulcrum of the weighting lever may be firmly fixed to the floor. A treadle is applied for removing the weight at doffing time. The machine shown (Fig. 65) is by Asa Lees & Co.

Besides the driving pulleys, the top roller shaft at its other end may have a worm for driving the bell shaft, the bell giving the signal that the hank has been treated the standard time, and that the middle roller must be released, either by hand or automatically.

Grease.—Occasionally a special grease is applied for certain yarns in the preparing machine, fine counts possibly more so than others, the professed object of this being to enhance the lustre and increase the compressibility of the yarn.

Soft brushes are desirable for this purpose and the grease should be applied sparingly and uniformly, the grease brush being held against the hanks for a few revolutions during treatment.

In a mixture of 50 lb. of preparing grease there might be approximately the following items and proportions; Japanese wax, 1½ lb., palm oil, 3½ lb., pure lard, 15 lb., cocoa-nut oil, 30 lb.

Liquid oils are unsuitable for preparing hanks as they run and spread, grease pots with screw plugs may be used, filled with special grease; solidified oil.

Preparing. Recent Improvements.

These are of especial benefit for fine and tender yarns.

1. The first improvement arranges for the automatic and gradual dropping of the weight which gives the pressure. This prevents cutting of the yarn due to sudden pressure applied to the bottom roller. The weight gradually rolls to the end of the long lever so as to increase the leverage—a principle which has also been applied to the faller weights of some spinning mules. It is possible to apply ball bearings to a preparing machine.

2. A second device is designed to prevent injury to the yarn resulting from sudden effort due to starting the bottom roller when this roller comes into contact with the yarn. With this object the bottom roller is driven by the top roller and the intermediate cotton roller running free. By means of suitable wheels, there is

given to the bottom roller, before it makes contact with the threads, a rather slower speed than it will have when driven by friction with the yarn and middle roller. The positive drive is by a free-wheel arrangement which permits the bottom roller to be driven at the quicker rate as the friction contact becomes stronger.

The automatic crossing motion has made it possible in some cases for a girl attendant to mind three or four machines instead of two.

3. A third device consists of an automatic stop-motion applied to the top roller by means of a loose pulley. This removes the danger of yarn breakages at the moment when the middle roller is introduced into working position, because of the rubbing of the top roller against the yarn while still stationary. This arrangement permits the machine to be started progressively, the sudden setting in motion of the yarn being dispensed with.

Of recent years various improvements have been successfully applied to preparing machines, such as automatic crossing motions, rolling weights on the long lever so that the weight shall come more gradually on the yarn; improved knocking-off motions and hank releasing motions; better main driving so that too much abrasion of threads in the driving of the rollers shall be avoided. The names of "Lefevre" and "De Bless" are associated with improvements in preparing machines.

A free chain gear may be applied to drive the bottom roller slowly from the top roller before contact with the yarn at starting.

The weight itself may be 65 to 75 lb. and a double leverage increases this very greatly. Experience and judgment are needed for the best results.

The heat of the calender rollers tends to melt solid grease in the grease box, and grease becomes conveniently applied by a pad.

Grease makes yarn counts heavier or coarser, and in some cases increase the yarn weight by about $2\frac{1}{2}$ per cent.

Wages of girl or women tenters for preparing are mostly so much per week, but there are cases of piece-work.

For preparing, lace yarn may be reeled into double hanks or double-double hanks.

For example there might be treated at one time, (1) five quadruple hanks, or (2) four sets of 5-hanks each, (3) 10 double hanks. Half of hanks to be placed in each holder of the crossing motion.

The attendant should shake out and straighten the hanks on the tension bowl and arrange them for treatment with the threads in as near parallel order as possible so that equal treatment of all threads is obtained. Automatic crossing may do the work better than a careless attendant, but not better than a skilful and careful attendant.

In the midst of the preparing treatment the woman attendant

either crosses the hanks by hand, or else an automatic crossing motion is applied. The object of crossing is to obtain uniformity of polishing treatment on all threads and the crossing brings threads from centre to edges, or from edges to centre.

Fig. 66 is a lecture diagram of a preparing machine.

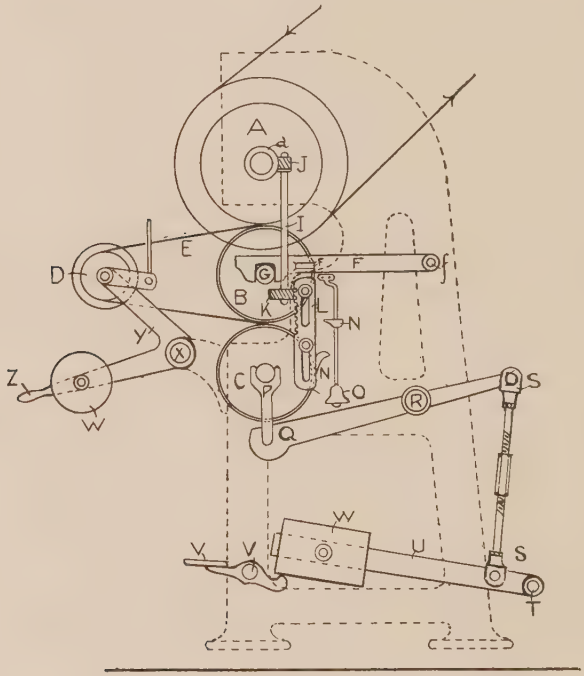

Fig. 66.

A = Top roller.
B = Middle roller.
C = Bottom roller.
D = Tension roller.
E = Yarn under treatment.
F, G = Latch for middle roller.
J, K, L = Lifting motion to unlatch F, G.
M, N, O = Bell ringing arrangement.
P, Q, R, S, T, U = Weighting arrangement for bottom roller with fulcra at T, R and link at S, S.
V, V = Foot releasing motion for weighted levers.
W, X, Y, Z = Weighting arrangement for tension roller D.

Broken tie-bands should be replaced before the hanks are removed from the machine.

One girl may attend two preparing machines.

The bowls or calenders should be kept free from oil and quite clean.

Either gassed or ungassed yarns may be prepared, but gassing usually intensifies the effects produced by such processes as preparing or mercerising.

Productions vary with counts of yarn, duration of treatment, speed of machine, and skill of operative.

Take a treatment of 3½ minutes, 2/80's counts, 80 r.p.m., 300-360 lb. per machine in a 48-hour week, made up into 10 lb. bundles.

Preparing Machines.

A preparing machine may be fitted with ball bearings if paid for as an extra.

It is possible for a female attendant to mind two preparing machines if she has to cross the yarn by hand, but the use of an automatic crossing motion might enable a competent person to mind four.

When the middle and bottom rollers are both of compressed cotton or compressed paper, the preparing effect proceeds simultaneously on top and bottom of the yarn.

After sufficient calendering the attendant may operate the foot lever to relieve the weight from the yarn and rollers. The centre roller is then moved outwards on its hinge, and the tension roller also in some cases comes nearer to the calenders. The yarn hank thus becomes quite loose for removal, and the fresh hank being put in is equally slack, and may be spread out evenly without interference from other parts. The centre bowl is then moved back into its operating position, the hank is tightened by the extension roller, and the weight released by the foot lever.

Automatic crossing motions ensure all parts of the hank receiving equal treatment.

Automatic knocking-off motions regulate the preparing to a uniform period.

Yarn Polishing Methods.

The underlying principle of any method of polishing is to pass the cotton yarn after doubling through some kind of paste or polishing mixture, and afterwards a rapid brushing may be applied to the yarn. The polishing process imparts a smooth finish to the threads, and also strengthens them. Loose fibres are either removed or are glazed into the body of the yarn. Both strength and weight of the doubled yarn may be expected to increase as a result of this polishing process. There are both hank and beam polishing machines. The hank machine may be worked on the upright principle, and serve for possibly 54 hanks, while the brush cylinder is fitted with a number of brushes in proportion to the width of the machine.

In the beam polishing process the beams containing the doubled warp threads are placed in a suitable creel, and the threads are drawn through a trough containing the necessary polishing mixture. After passing through expression rollers the threads are operated upon by rapidly revolving cylindrical brushes, and are afterwards wound upon bobbins adapted for taking to the creel of the spooling machine.

To obtain the best polishing results it is necessary to build up the creel bobbins in a good, regular manner, the tension of the

Hank Polishing Machine.

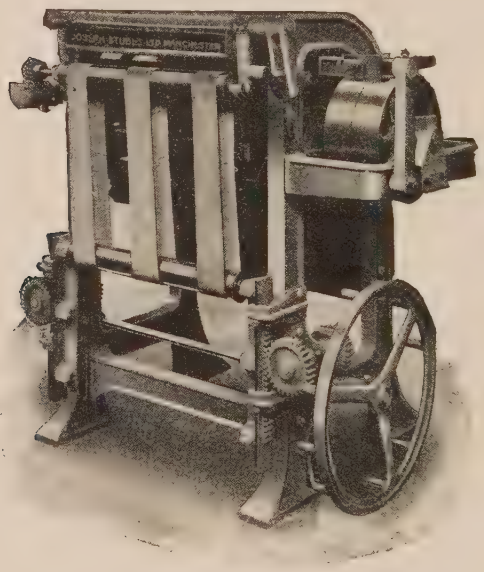

Fig. 67.

yarn being sufficient to pull the bobbins round in the creel. It must be remembered that fine yarns will not withstand as much brushing as coarse yarns, and a single brush machine is often used for fine yarns. Polishing in such a manner is well adapted to some kinds of sewing thread.

There is a certain amount of business in the polishing of hanks of cotton or other yarns, and a machine for the purpose is shown in Fig. 67 as made by Messrs. Joseph Stubbs Ltd. The cylinder may be fitted with any number of brushes or wood lags up to thirty-two as required. Rollers made of brass or of wood covered with tin.

Tension on the hanks regulated by a foot wheel at side of machine.

About 350 r.p.m. for driving pulleys of 14 × 3½ inches diameter.

Elasticity in Cotton Yarns.

There has been much greater demand in late years for yarn possessing this property, as it has been found most valuable in many processes for which yarns of good quality are used. For example, in the use of fine single yarns of 100's and upwards, for warps, for muslins, etc., and all other fabrics where a fine yarn has to be used in the single state and very lightly sized, that there is a certain definite percentage of elasticity which will give good results and greatly reduce breakages. Thus, it is possible to have two yarns pulling the same strength per lea exactly, but the percentage of stretch, or as it is usually termed elasticity, in one is 5 per cent., and in the other 3½ to 4 per cent. The first will give considerably better working in all processes up to and including the loom.

It is now by no means unusual to have a yarn ordered with not less than 5 per cent. of elasticity for a certain strength per lea.

This property is also valuable for the doubling trade as, all things equal, an elastic yarn is much better for doubler than an inelastic. Thus, for example, yarn is required to be delivered as 90/2. With a yarn possessing a good factor of elasticity a doubler can buy 84's single, and with the drag during doubling produce 90's or even 92's easily, obtaining also at the same time a stronger and more compact thread. With a yarn which is inelastic, he may have to use single counts of the same, or even finer counts than his resultant two-fold. An inelastic yarn does not make a good two-fold as it does not coalesce to anything like the same extent as an elastic yarn.

There are also yarns which are used as wefts for fabrics which are afterwards clipped or sheared and raised when the elasticity of the weft is a determining factor in the feel of the pile.

There has been at times considerable demand for yarns which are artificially elastic, that is, spun with considerable extra twist in order to produce a contractive effect. Thus, for example, say counts from 30's to 70's with a twist of $\sqrt{\text{counts}} \times 6$, are used to form effects in fabrics by their contractive properties allowed to appear at certain positions. In these yarns, spun on the mule, the elasticity is the primary factor, and with care and skilful manipulation fully 7 per cent. of elasticity can be obtained.

Strength is quite a secondary feature in these yarns, and their use is greatly on the increase.

Preparing (Fig. 68).

The effect which this process exercises upon yarns may be expressed as a function of three distinct factors. (1) The pressure applied, (2) the time during which this pressure is applied, (3) the speed of the machine. Dobson & Barlow's machine is shown in Fig. 68.

Taking these in order it may be stated that the pressure when

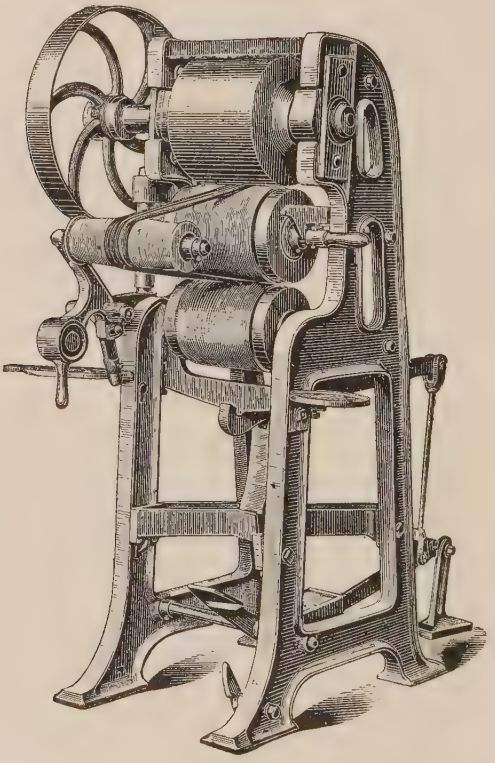

Fig. 68.

once fixed is constant for one operation or one count; the time during which this pressure is applied determines, along with the speed of the machine, the total number of applications of this pressure to any given place on the hank, and the speed of the machine determines the frequency per unit time of the application of pressure to any given place.

When strong folded yarns are under operation the weight can

be increased because the greater resilience of the folded yarn offers greater resistance to crushing. With increases in the pressure applied, the speed of the machine, or what is more usual, the time of treatment can be reduced, as the greater pressure produces its effect with a lesser number of applications. When fine single yarns are under treatment, the process must be revised and the weight graded, as the weight suitable for a two-fold yarn would cut a finer single yarn. There is a great amount of trade done now in single yarns for the net trade, and for this purpose the preparing process, if effectively carried out, results in great economy at the net or lace machines. For example, a brass bobbin formed with flanges set just far enough apart to allow the thread to lie between, made $1\frac{1}{2}$-inch diameter full size, and $1\frac{3}{16}$-inch diameter at the bottom where the thread commences to wind, filled with unprepared yarn from the cop (100's counts), will just take 60 yards, and with the same yarn after thoroughly preparing 89 yards can be wound into the same space.

To prepare this single yarn successfully, then it is necessary :—

1. To cross reel the hanks, and use as soft a tie yarn as possible consistent with strength required.

2. To reel the hanks large enough to obtain thorough cushioning, without getting them so large as to make the effect uneven.

3. To reduce the weight or pressure to a degree consistent with the counts of the yarn, and obtain the required effect by increasing the time element.

4. To prevent the weight coming suddenly upon the threads between the rollers when starting a new hank, either by dropping the weight too suddenly on the bottom roller, or by the jerky starting up of the machine when the middle and bottom pressure rollers delay in coming up to speed. Both these defects may be obviated by recent improvements which are capable of attachment to the machines.

5. By strict attention to the surface of the paper bowls, as a slight unevenness which would not be noticeable with a folded yarn, will cut a single yarn very readily. To use also an efficient spreading motion.

Ring Grease for Doubling Frames.

This is specially made not to stain yarns which may come into contact with it (a very frequent occurrence as the bobbins are becoming full, and where the rings are greased, otherwise than at empty bobbin). In ordinary two-folds, which have not to be gassed, the grease does not leave any stain, and cannot be detected after preparing.

In two-folds which have to be gassed, every portion of the

thread which has absorbed grease blackens very badly, through the carbonisation of the grease in the heat of the gas flame. This is very often attributed to "sooting" even in the trade.

Chloride of Magnesia.

If this is used in conditioning or in water troughs great trouble results if the yarns have to be sized, as it keeps the size soft, and robs it of the crisp feel which is necessary for many purposes. Its great disadvantage is in connection with cloths which have to be singed in finishing, and very many more fabrics than is usually thought pass through this process. The heat of the singeing process decomposes the chloride and liberates free chlorine gas. This attacks with great avidity the cellulose of the fibre and completely rots it, with the result that these cloths sometimes come out from the singeing process with small holes over the piece.

Traverse Speeds and Winding Speeds in Drum Winding.

Softness or hardness of bobbin or cheese of yarn, webbing or running off at the ends of the bobbin, quantity of yarn put on the bobbin or cheese, counts of yarn, number of doublings or folds, and length of spool, are the chief factors in determining the relative speeds of winding-on and traversing of the yarn. The lateral traverse should be sufficiently quick to limit or prevent webbing or running off at the ends of the bobbin, and prevalence of this evil would be a reason for speeding up the traverse in relation to the drum. On the other hand, the traverse too great in proportion to winding-on, we might produce the evil of soft bobbins or cheeses, and insufficient length of yarn wound on each full bobbin. With split drum winders it might be necessary to obtain fresh drums to alter the ratio, but with other kinds it should be quite convenient to make the alteration, as for example, in one frame the traverse could be speeded by applying a different diameter of rope pulley for the traverse. If we changed from two to three or more folds on a doubling winder, or changed to harder twisted yarn it might be advisable to use a quicker traverse to prevent bulging at the bobbin ends. For example, on the Hill and Brown split drum winder in such cases it is often necessary to use double cam drums so as to give the extra crossings necessary to prevent running off. Using empty spools of larger diameter will sometimes prove a remedy in such cases.

CHAPTER XII.

COTTON GASSING.

Statement.

Both carded and combed spun cotton yarns show many projecting ends of fibre when held in a proper light, and these projecting fibre ends increase the bulk or diameter of the yarn, and make the counts coarser, without giving much, if any, strength to the yarn. Doubled yarns also benefit by gassing, for some purposes.

The gassing process removes the bulk of such projecting ends of fibres, makes the yarn smoother, finer, more compact and more lustrous. The increased lustre of gassed yarn probably results from the reflection of the rays of light not being obstructed by the loose fibre. The gassing process is about a hundred years old.

On the whole there is more loose fibre in mule and twiner products than in ring yarns, and least in a flyer frame yarn, because the mule spinning process develops throwing out of the fibre ends, while flyers and traveller of frames rule them down somewhat, and there is a very short length of yarn from rollers to bobbin.

Gassing of cotton yarns has increased in quality yarns owing to the proved fact that mercerising is more successful on a gassed yarn. Gassing of cotton yarns is a very old business, almost stagnant for a time, but developing rapidly of recent years, both in methods and mechanism.

Efficient gassing does not weaken the yarn although making it from 5 to 10 per cent. finer; thus a 74's plain yarn may become an 80's gassed, or a 93's plain become 100's gassed, the fine yarn maintaining the strength of the coarser and plain yarn if the gassing is done with care and skill. Excess gassing effect, wrong speeds of thread, badly regulated heat, wrong twistings in the thread, may lead to weakening of yarn. Gassing often discolours the thread, but this is not always a very bad fault so long as scorched or stripy yarn does not result.

Objects and Features of Cotton Gassing.

Cotton gassing or singeing has for its primary object the burning away of the loose projecting fibres or ends of fibres which add to the weight but not to the strength of cotton yarn.

Properly performed singeing may make the counts about 6 per cent. finer without diminishing the strength.

Gassing or singeing removes loose fibre, makes cotton yarn finer, adds to delicacy and fineness of appearance, makes the yarn thinner and more concentrated, and facilitates the lustre-giving properties of mercerising.

The expensive idea of actually burning spun yarn away is somewhat redeemed by the higher price per lb. obtainable for yarn which is several counts finer.

From 5 to 10 per cent. are the usual limits for making cotton yarns finer and lighter by gassing. Twist in doubling makes yarn coarser, as also do wet doubling and conditioning.

A gassing frame is a simple machine of the drum winding type, either slow or quick traverse.

The essential features in its construction are as follows: (1) A suitable creel for the bobbins or cops; (2) suitable guides for conducting the yarn from creel, through the flame, and upon the finished bobbin or cheese; (3) the actual gassing or singeing arrangements; (4) method of placing the thread in and out of contact with the flame.

About 36's plain for 40's gassed, or 72's plain for 80's gassed, is a good basis.

It is customary to have a main gas pipe running the length of the frame, with a main tap or valve, or else a pipe to each side of the frame, and a stop-tap to each. There is a small branch pipe for each burner, each with its own tap. Allowances for loss of weight in gassing, gain of weight in wet doubling, differences of length in reeling, possibly making yarn one or two counts thinner in preparing, or heavier by polishing, need care in reckoning.

Defects in Gassing.

It is well known that the process of cotton yarn gassing involves passing the yarn rapidly through a very hot gas flame, at a speed which is too great for the body of the yarn to be burned, but which is sufficiently slow to permit the loose and projecting end of fibres to be burned off. To obtain the required amount of gassing effect when using the ordinary brass or aluminium revolving bowls usually require the same thread to be passed several times through the gas flame. The process of gassing makes the yarn browner, barer, and finer, and peculiarly fits it for the lace trade and for many mercerised goods. If well and moderately done, gassing ought not to make the yarn appreciably weaker or more tender, but blackening and tendering may result from imperfect blendings of air and coal gas, from the use of dirty burners, unbalanced and ill-proportioned speeds of yarn in relation to the heat of the gas flame, and

generally speaking by over-gassing, especially if the yarn be only soft-twisted. Blackened yarn without tendering may result from bad and unsuitable gas, dirty burners, and possibly the use of gas containing an insufficient amount of ordinary air.

Striped yarn may result from variable amounts of gassing, whether caused by slip of the cheeses against the drums so as to give a variable speed of yarn, or from one yarn being harder twisted than another, or the intensity of the heat of the gas flames varying so as to act on some yarns or portions of yarn more than upon others. Discoloration of the yarn in gassing is a very common defect, and a moderate amount is not much troubled about in many cases. Choked burners, variation in intensity of heat, incorrect and variable regulation of the gas flames, and variation in the pressure of gas may cause such defects as discoloration, scorching, and striping of gassed yarn.

Ungassed places sometimes result from frequent and careless or unskilful piecing-up of broken threads, and re-starting of cheeses after making piecings; also in some cases owing to an imperfect connection between the levers and fingers which control the side movement of the gas jets and the simultaneous movement off the cheese of yarn into touch with the driving drum. Ungassed portions of yarn and piecings of yarn are often diminished in modern gassing frames by the use of long bottle-shaped bobbins in the creel, such bobbins holding a good deal of yarn.

Gassed Yarns for Warps.

There are certain branches of the gassing trade in which it scarcely pays to go in for high speed gassing upon quick-traverse cross-wound cheeses. For example, a good quantity of gassed yarn is used in the preparation of warps for some kinds of woven fabrics, and the more usual practice in such cases is to make double-flanged, slow-traverse bobbins on the gassing frame.

The ordinary gassing frame may be made with self-contained creel spindles for side unwinding, or with rails drilled to receive cop skewers, or with special small adjustable angle brackets to receive cop skewers, or with pegs to permit unwinding endways. Adjustable flannel drag-boards are sometimes used on gassing frames. We are not forgetting for a moment that gassed yarn put upon bobbins or spools without flanges permits greater lengths on the cheeses, better handling and transport, gives fewer knots, fewer doffings, and greater productions than when the yarn is placed upon double-flanged bobbins.

In spite of all these advantages it may yet pay a doubling mill to have one or more slow-traverse gassing frames to unwind yarn from revolving bobbins or cops, and place the same upon double

flanged bobbins. It is sufficiently well known that it is difficult to make good warps from cheeses of gassed yarn, although this is more or less in vogue. If, however, the warping trade is to be met it is possible to use a gassing frame which gasses direct upon the 5-in. and 4½-in. warper's bobbins. The eminent firm of Messrs. Arundel, in order to meet this special line, have constructed a patent combined quick and slow-traverse gassing frame, which is made exactly the same as their ordinary quick traverse, with the exception that the cam motion is driven through a patent differential motion, and the guides are of a special swivel pattern. When required for making cheeses for export or reeling, the differential is locked together, and the cam motion is driven direct. For gassing upon warper's bobbins for warping, the guides are swivelled over, and the differential is unlocked, the whole work only requiring a few minutes. It is usually made 7½-in. gauge for 5-in. lift warper's bobbins, and 4½-in. traverse cheeses. Full instructions and sketches are supplied by the firm for adjusting the patent cam motion. When warper's bobbins are prepared from cross-wound quick-traverse cheeses of gassed yarn, a winding frame may be used between the gassing frame and the warping frame, and it is no easy matter in such a case to obtain equal tension of the yarn, sufficiently few breakages and knots, and satisfactory bobbins for the warper. The winding speed is often too high, and is too variable to ensure sufficiently good work from cross-wound cheeses of gassed yarn, because of the varying diameters and the large crossings of yarn. Breakages of yarn are usually too frequent, and after a breakage it is not easy to make the piecing at the required exact point opposite the bobbin. A close spiral is usually best in such cases, as the defects show up prominently at the warping process, whether beam warping or mill warping.

An essential requirement in such warping is that uniform tension should be put upon the creel bobbins, and it is far better that there should be few piecings and few wide crossings of the yarn.

If the creel of a gassing frame is arranged for end unwinding from cops, it is advisable to conduct the yarn upwards from the cop around specially constructed guide and tension wires; but if for side unwinding from double or other bobbins these upper wires may be omitted from the passage of the yarn. It is not to be forgotten that with side unwinding from revolving bobbins at the gassing frame the speed of the yarn is largely regulated by the strain the yarn will stand in pulling round the spindle and bobbin, and under such circumstances the usual 7-in. diameter drum was limited to speeds of possibly 120 revolutions or less per minute. End unwinding in any machine often imposes more strain on the yarn than is altogether advisable. In these gassing frames also

the gassed yarn would be probably wound upon double ended bobbins of $2\frac{3}{4}$-in. traverse, and only 3-in. diameter or less, as compared with double this diameter and greater width now in common use. In any machine it is a distinct evil to have very small creel bobbins, or to make very small bobbins, because of the increased work in doffing and the greater number of piecings and knots. Perhaps reeling would follow gassing more often than not, and it is very clear that reeling from small double-flanged bobbins of small lift and small diameter would limit the speed and production at the reel.

Some of the evils in gassed yarn come under such headings as "stripy" yarn or "scorched" yarn, and "sooty" yarn. "Stripy" yarn may be caused by uneven gassing due to such causes as choked burners, incorrect regulation of gas flame, or speed of thread, variation in intensity of heat of gas.

The reeler is perhaps much better suited with the cross-wound flangeless cheeses of gassed yarn than is the warper, and in reeling much higher speeds were attained by the adoption of the quick-traverse gassing frame, the 54-in. reel being increased from possibly 140 r.p.m. up to double this speed by this single improvement. As before stated, at the gassing frame the adoption of the tapered or bottle bobbins finally disposed of any limits of speed imposed by the unwinding from creel bobbins at the gassing frame. The adoption of the tapered bobbin has been placed at about 1894, and of the quick-traverse gassing frame at possibly 1888, but naturally it takes usually a long time to get improvements in the spinning and weaving of cotton very largely adopted.

Gassing One Hundred Years Ago.

In 1836 Dr. Ure wrote as follows :—

"The fine cotton yarns which are intended for making bobbinnet lace thread, and for the hosiery trade, are generally subjected first of all to a singeing process by the flame of coal gas, in a peculiar machine, to free them from their loose, divergent fibres, whereby they not only acquire a more level and compact appearance, but are raised to a higher number by the diminution of their weight per hank. In this way No. 90 yarn will become 95. The machine for this purpose may be said to consist of a series of gas-jet flames, through every one of which a thread is made to pass several times with a velocity corresponding to the quality of the yarn. The motion is given by the revolution of winding and unwinding bobbins turning from 2,500 to 3,500 times per minute. After singeing the yarn is either reeled into hanks from the bobbins or sent to the doubling mill. The winding process in the gassing machine will serve to illustrate the manner in which yarn is wound

from the smaller bobbins of a throstle frame upon the larger bobbins of a warping mill, with the addition of a contrivance for arresting the mechanism whenever a knot or foul point occurs in the thread. This modification is introduced in the gassing apparatus to prevent the flame from burning the thread when its rapid movement is thus stopped. The gas flame is, by this curious contrivance, suddenly turned aside, while the bobbin is at the same time lifted off the rotating barrel which turns it by friction, and is left at rest until the tenter female has had leisure to draw the knot through the slit, or to mend the defect. She now presses the bobbin down upon the carrier barrel again, and restores the gas flame to its proper position under the running line of the yarn. . . . The tenter is paid according to the quantity and goodness of her work, who in casting her eye over the machine sees at a glance whether the bobbins are properly working or not. Having corrected any defects she starts the apparatus again merely by depressing the proper handles."

The above extracts from a work written so many years ago cannot fail to be interesting to anyone who is seeking in any way to acquire knowledge in regard to the gassing process, or who may be more or less directly connected with present day practice. Dr. Ure also gives one or two decent illustrations with nicely worded descriptions, and two or three items are very self-evident from a casual examination of these sketches. For example, the drum driving of the tube or spool containing the gassed yarn, and the use of grooved brass bowls catch the eye at once, and serve to show how closely the bulk of modern practice adheres in the essentials to the principles adopted well on for a century ago.

Modern Developments.

At the same time it is not to be overlooked that several very important developments have occurred recently which have very materially aided the work carried on in a gassing room. Special apparatus for obtaining a more intense or a hotter flame while keeping down the gas consumption, removing objectionable smells, securing more uniform strength in the jets, removing the foul air and the products of the gassing process, have received very successful attention, and it is more than likely that the near future may witness further developments along these lines.

Long ago it was found to pay far better to do all the clearing at a machine which precedes the gassing frame, and in the doubling trade comes between the doubling frame itself and the gassing machine. The use of the intermediate clearing machine has moreover led to the use of comparatively large bottle-shaped bobbins,

which are often of immense benefit in facilitating the work of the gassing frame. It may be laid down as a fundamental principle that any reasonable means which are adopted for helping on the work at the gassing frame will likely enough be found to be a profitable investment. A gassing frame possesses certain inherent principles which render it inadvisable to arrest the process—either as a whole or in the case of individual lights—any more frequently than may prove to be absolutely necessary. For example, it is no easy matter to stop and re-start the process without allowing a limited portion of more or less imperfectly gassed yarn to pass forward, although a skilful operator will reduce such defective work to a minimum.

Vertical Gassing Frame.

The following is a brief description of one of the most modern of gassing frames. Vertical gassing frames have been attracting attention for the last few years, and permit speeds in the gassing of cotton yarns not attainable with the brass bowls. Two or three leading makers are identified with the construction of vertical gassing frames, and Rivett's patent vertical burners and patent drums are included in a gassing frame made by Messrs. Asa Lees, as described briefly below, and as examined by the present writer. They say: "Around each burner is fixed a vertical shield, forming a chamber in which the flame burns, and through which the yarn passes in an upward direction. The advantages of this burner and shield are that the yarn is in contact with the whole length of the flame, thus ensuring a better gassing; a much smaller quantity of gas is consumed, and a more perfect combustion of the fibre taken off the yarn, and consequently a better atmosphere is secured. The burner shield is provided with a slot extending from top to bottom, so that the yarn can be very quickly thrown into contact with the flame. The levers controlling the yarn guides are connected with those carrying the spools, and ensure the yarn being put in the flame as soon as the spool comes into contact with the drum. The construction of the drums causes the yarn to be traversed without the use of a separate motion, there are therefore no traverse bars in the machine, and the working is practically noiseless. Each patent drum is provided with a slot which automatically takes the yarn into the traverse groove as soon as it touches the drum when piecing up. The drum can be run at a speed of 600 and 800 revolutions per minute, thus giving a production four to six times greater than is obtainable on other gassing frames. On this account fewer hands are required, and a great saving of space is secured."

Brass Bowl Arrangement.

For probably longer than anyone living can recollect, a central feature of most gassing frames has been the use of small brass bowls round which the yarn passes several times, and which are quickly revolved by frictional contact with the yarn. These bowls are extremely convenient for permitting the same yarn to be rapidly drawn several times in quick succession through the same gas flame. At the same time, since each bowl may contain possibly five grooves, it is convenient for permitting the passages to be varied readily from two or so up to eight or nine, according to the number of times the yarn is taken round these bowls. The use of these bowls in large quantities has led to the construction of special machines for making the bowls automatically—somewhat after the principle of the well-known automatic machines for producing studs of one kind or another. Anyone seeing these bowl-making machines at work at certain of our machine-making works must have been greatly impressed by the rapid and ingenious manner in which the bar of brass is fed, cut up, grooved, turned, and drilled, so as to produce the comparatively light and elegant brass bowls we are so familiar with. Although these bowls are nearly always made of brass, and are easy to turn by the yarn when kept clean, it is possible to have them made of aluminium, if required, and eminent firms are prepared to supply a special pattern aluminium bowl with an improved phosphor bronze bush arrangement.

Although so admirably suited for their special purpose, these light grooved bowls are by no means free from defects, and in one respect there is a close resemblance between these bowls and the bowls of the bowl box of an opener or scutcher. The latter are liable to become more or less clogged with fly, and to develop friction, which seriously interferes with their regulating efficiency, so that at least partially on this account, various forms of link, lever, and tripod arrangements have come into general use, in which the bowls and bowl box are dispensed with.

In like manner there is a gummy substance produced in continually passing the cotton yarn through the gas flame, and this frequently interferes with the free revolution of the brass bowls, and unless the bowls are taken off at suitable intervals, steeped in some kind of cleaning liquid for a short time, and then wiped clean, it is very likely there will be excessive breakage of the threads.

There can be no manner of doubt that any amount of trouble and complaints of inferior yarn have been given in times past, owing really to insufficient attention to the proper cleaning of the light brass bowls. A weak mixture of brown or black ash and water, or even soft soap and water will prove effective in helping to clean the gassed cotton gum from the brass bowls.

Ventilation of Gassing-Room.

A good many people well acquainted with mill conditions have expressed the opinion that the gassing-rooms of many mills have been the most unhealthy in the whole range of cotton mill processes. This remark does not apply to all gassing-rooms, but in all cases the problem of effective ventilation without interfering with the processes has proved a difficult one. The increased necessity of ventilation in a gassing-room is due to the fumes, products, smells, and heat generated by the gas, and its effects upon the cotton yarn. While it is readily perceivable that the gassing process creates an atmosphere which badly needs ventilation, it should be equally clear that the gas lights must not be affected by the air required for ventilating purposes. This is so well recognised that many firms have built special sheds for the gassing departments, while others have gone in for top rooms to be used for gassing. In these cases the problem is somewhat simplified, and especially if there are wide alleys and passages in the rooms, by the possibility of permitting the air to enter through ducts running along the floor of the gassing-room over the full length thereof, passing upwards without much affecting the operatives, or the gas lights or the cotton yarn, and escaping at the ceiling. The air-ducts are perhaps best placed between the floor. One of the most modern arrangements for the ventilation of gassing rooms may be applied in connection with Messrs. Arundel's new patent vertical burner, split-drum, gassing frame. In this case a burner of considerable length and arranged vertically is used, and there is only one passage of the yarn through the gas flame—or in coarse counts two passages—instead of several passages as by the grooved bowl system. Each burner is provided with a hood, which is connected at the top with a common duct the whole length of the frame. At the end of the frame a fan is fixed, and the whole of the products of combustion and burnt fluff are carried along these ducts into a special chamber, where they are deposited in water. It is only necessary to clean out this chamber occasionally, according to the counts of yarn gassed. There are undoubted advantages to the work-people in the absence of smoke, smell, and fluff in the gassing-room, and it does really seem in these progressive days that the required hygienic conditions should be obtained.

A perusal of the foregoing remarks will not only show the difficulty of obtaining the required health conditions, but also the direction in which efforts have been made in times past. It must be remembered that gassing is a very old industry, and the ventilation problem has often received consideration. The vertical gassing frame up to the present time has only received a moderate amount of adoption, but an important feature of the machine just

described consists in the fact that the ventilation is entirely self-contained, and can be fitted in any room without the expense of putting in fans or air-ducts. It is simply necessary to connect the fan on the machine with the open air.

We may add that during recent years a good deal of attention and experiment have been devoted to the question of singeing by electricity instead of by gas, and if this transformation were to really and extensively take place, the ventilation of the rooms under discussion ought to become a much more simple matter.

Modern Procedure for Gassed Two-folds.

After spinning the single yarns twist way we have the doubling process, which may be either ring doubling or flyer doubling, and may or may not be preceded by the doubler winder, this latter being the more up-to-date method.

Following the doubling frame we have the clearer winding process, and the modern custom is to wind upon large bottle-shaped, single-flanged bobbins on a "Rabbeth" spindle winder, using special tapering mechanism to obtain the large bottle-shaped bobbin. These bobbins somewhat resemble in shape huge cops, and permit subsequent unwinding over the top, at any required speed, at the gassing frame.

The threads are drawn through adjustable clearer slits, mostly on the Suggitt principle, at the winding frame.

The large bottle-shaped bobbins are next placed in the creel of the quick-traverse cotton gassing frame and unwound over the top. Compared with former kinds of twiner cops, ring doubler bobbins, or other creel arrangements, these bottle-shaped bobbins give the following advantages: There is comparatively little breakage or waste, fewer knots and stoppages, a less amount of ungassed yarn. One operative may attend to many more lights, and productions are distinctly greater.

Reeling follows gassing and puts the yarn into hank form, suitable for transit, or for preparing, or other special treatment.

The quick-traverse small tube is now in favour for placing the gassed thread upon, and permits quick reeling over one end of the cheese.

The slow traverse and small flanged bobbins could be applied if ever wanted.

Burners and Small Grooved Bowls.

The great feature of cotton thread gassing lies in the fact that each thread is usually drawn rapidly through a gas jet several times—say about seven usually. The burners used vary in cou-

struction, but are mostly of a Bunsen type, so arranged that there is a small amount of flame and a proportionately increased amount of heat. For this purpose a certain amount of air is allowed to pass into the burner along with the gas. The burner may be arranged transversely so as to gas each thread to a small degree six or seven times. The brass or aluminium bowls round which the threads pass are made to revolve very easily, and are pulled round by the friction of the threads passing round them. The threads are pulled from a specially constructed creel, round guide rods, and after gassing are wound usually into small cheeses by frictional contact with revolving drums. There is a swivel arrangement by which the gas jet can be moved out of the path of the thread during the piecing of broken threads, etc. After gassing, the threads appear to be much browner than previously, and gassing is performed in order to make the thread to imitate silk, concentrate it, and when it is going to be used for lace purposes. During the passage of the thread through the flame the loose, oozy fibre is burnt from it, and this makes the yarn finer, and has to be allowed for in the counts of ungassed yarn. For instance, if 100's gassed yarn were required, we might have, say, 94's ungassed yarn. A steady flame and a uniform speed of the machine are necessary in order to give a uniform amount of gassing.

High-class handkerchiefs, neckties, ribbons, underwear, fine socks or stockings, etc., made partially or altogether from good cotton yarns, gassed, and probably dyed, may pass very easily as silk goods with many people, especially if the yarn is also mercerised.

The small bowls and other parts are apt to get sticky and dirty as the result of the burning of the fibre, and care should be taken to ensure sufficient attention to cleaning.

The Process and Yarn Passage (Fig. 69).

Referring now to lecture diagram, fig. 69, the yarn is shown as being drawn from the ring-frame bobbin at A′, but may be taken from winding frame bobbins disposed as at A, or from large bottle bobbins. The ungassed yarn passes upwards and over the guide and tension wires at G, and then extends downwards and passes in a crossed fashion several times round the bowls, D and D′. A bowl is shown separately at X. The bowls rest loosely on pins carried by the adjustable brackets, C and C′, which latter are supported by the stands, B and B′. The gas issues from the burner at E, in such a manner as to meet the yarn at the crossing of the threads. After gassing, the thread passes downwards over the guide rod at F, and upon the cheese at Q. The latter is rotated at something like a uniform surface speed by resting on the revolving drum, R. The

weight, W, is suspended from a chain, S, which passes over the guide bowl, T, and is then attached to the cradle lever, M, which carries the cheese or bobbin, Q, of gassed yarn. In this way the frictional contact of Q with R is maintained.

For piecing-up and other purposes the attendant pulls at the

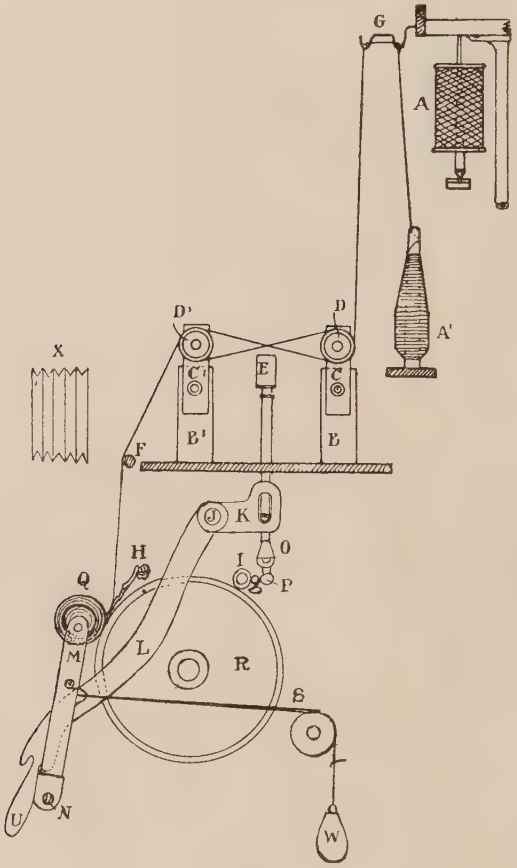

Fig. 69.

handle, U, of the lever, L, fulcrumed at J. This has the effect of pulling the bobbin holder, M, forwards, and the bobbin, Q, away from contact with the revolving drum. N is the fulcrum of the bobbin lever, M. At the same time the burner E, is swivelled on one side on its fulcrum at P, so that the gas is no longer acting on the yarn.

After piecing-up, the dropping of the lever, L, almost simultaneously permits the gas to come under the yarn, and the cheese, Q, to come in contact with the drum, R. The gas enters at I. In the burner shown air may enter at O.

The gassed yarn is wound on to wooden tubes, dispensing with

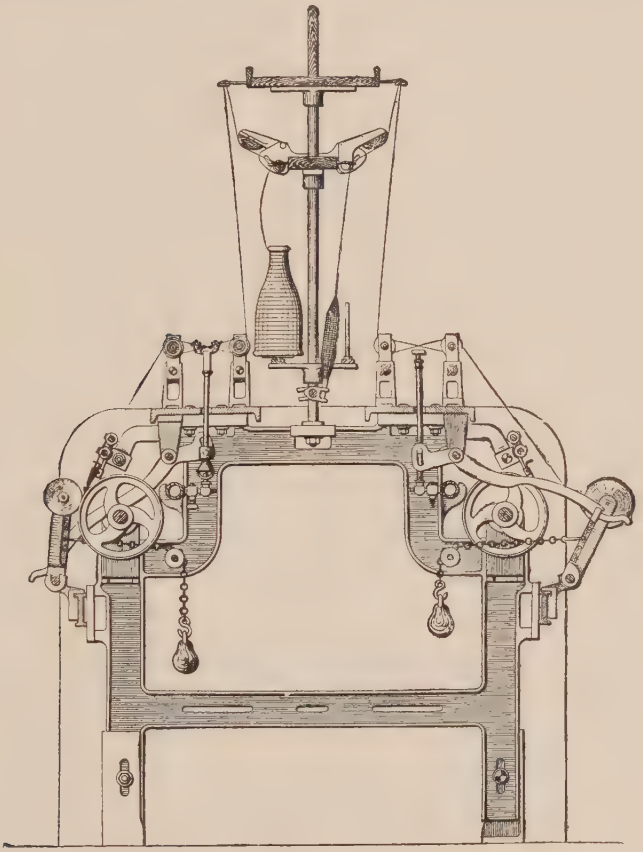

FIG. 70.

the expensive cost of bobbins with heads. The bobbins made on this principle can be reeled off endways instead of having to be reeled from a revolving spindle, consequently bobbin-reeling is dispensed with or converted into the process of cop-reeling, which means that the speed of the reels can be much greater, and a

considerable saving in the cost of reeling. The reeler's work is diminished as compared with reeling from double-headed bobbins.

Messrs. Dobson & Barlow's Gassing Frame (Fig. 70).

A cross-section is shown in Fig. 70.

The frame is strongly built and embodies considerable experience.

The gassed yarn may be wound upon wooden tubes, instead of flanged bobbins. Cheeses made on this principle can be reeled over the end instead of sideways, which item reduces cost of reeling and permits higher speeds of reels. Not only does this over-end reeling dispense with labour, but one full gassed cheese will contain very much more yarn than with two-headed tubes—from four to six times as much has been claimed. Naturally this of itself means less creeling, fewer piecings at the reel, fewer knots, fewer breakages and generally it eases the work at the reel.

Machine cut traverse cams are used, and very light traverse rods. Burners of various types according to specification. In Fig. 70 the yarn is shown entering the inside bowl, but in some gassing frames the yarn enters the outside bowl. The use of cops of yarn in gassing frame creel has greatly diminished of recent years, in favour of large bottle-shaped bobbins. Both methods are shown in Fig. 70.

Eighty drums to 1 m.h.p.

Driving pulley 12 inch diameter × 3 inch wide, 120 r.p.m. single yarn, 100 r.p.m. doubled yarn.

Messrs. Dobson & Barlow give the following list of productions (see p. 291).

Bowls and Lights.

Lights may be turned higher or lower to regulate gassing effect to yarn requirements. Soft twisted yarns are more easily flame injured than harder ones.

A wide flame is needed to encompass all the five to nine passages of thread at one time.

Occasionally burners have been fixed in two or three branch holders, or double and triple burners have been used, there being two or three lights behind one another.

For the coarsest doubled yarns the gassing process is sometimes repeated two or three times over to get the full effect, and the brass or aluminium bowls may be rather larger in diameter. For fine voile or lace two-folds the pitch of the bowls $\frac{1}{16}$-inch, for somewhat coarser work $\frac{1}{8}$-inch, and for counts as low as two-fold 3's the pitch may be $\frac{1}{4}$-inch; width of light being correspondingly adapted.

A four-groove bowl may give eight or even nine passages of yarn through the flame if the creel bobbin is placed behind the lights. Single and soft yarns may have 3, 5 or 7 times through the light, but 7, 8 or 9 times is more common for harder twists and folded yarns.

Under average well-established conditions and gassing all kinds and counts of cotton yarns it has been ascertained that from 1·2 to 1·3 cubic feet per light per minute may be used.

The grooved bowls should not be placed too close together as

Productions of Gassing Frames.

Counts.	Revs. of Drum Shaft per Minute.	No. of Times Through Light.	Hanks per Drum in 10 Hours.	Lb. per Drum in 10 Hours.	Hanks per Drum per Week of 56½ Hours.
				2-Fold.	Single.
30's 2-fold	100	7 to 9	43·18	2·878	244
40 ,,	100	7 to 9	43·18	2·159	244
50 ,,	100	7 to 9	43·18	1·727	244
60 ,,	110	7 to 9	47·43	1·584	268
70 ,,	110	7 to 9	47·43	1·355	268
80 ,,	110	7 to 9	47·43	1·185	268
90 ,,	110	7 to 9	47·43	1·054	268
100 ,,	110	7 to 9	47·43	0·948	268
110 ,,	120	7 to 9	51·85	0·942	293
120 ,,	120	7	51·85	0·864	293
130 ,,	120	7	51·85	0·798	293
140 ,,	120	7	51·85	0·740	293
150 ,,	130	7	56·10	0·748	317
160 ,,	130	7	56·10	0·701	317
170 ,,	130	7	56·10	0·660	317
180 ,,	120	7	51·85	0·576	293
190 ,,	120	7	51·85	0·545	293
200 ,,	120	7	51·85	0·518	293

Note.—For every extra fold in the yarns, the drum shaft should run 15 to 20 r.p.m. slower.

The above productions are for hard-twisted yarns—good quality of gassing.

this permits the light to heat the bowls and studs and burns up the lubricant, so that the very detrimental effect of swiftly running bowls is obtained, 11 inches or 12 inch centres are suitable, but 7 inches and 8 inches may give defect specified. The author has seen gassing frames at work with 7 inch centres and this reduces the width of frame, but with big lights may heat the bowl studs. In every case it is necessary to periodically remove the bowls and clean them by placing in boiling water and soda ash, and too much

repetition of this business becomes a great nuisance, as they often need replacing on their own studs, but not usually so.

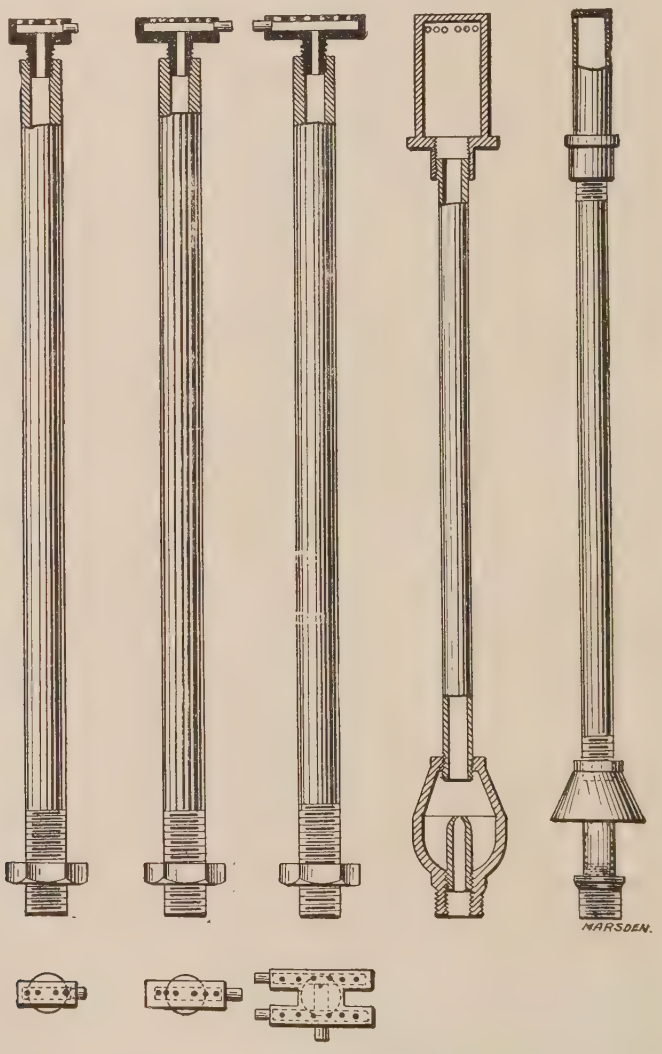

Fig. 71.

Various kinds of burner as supplied by Messrs. Dobson & Barlow, are shown in Fig. 71. There are still other types.

Burners.

Some burners have been made for only gas, some for gas and air mixtures, some for fine counts, others for coarse counts. Some burners have vertical holes to give a vertical flame, while others are slanting apertures which widen the flame. For example, there is the T burner, the H burner and the H, H, giving respectively double and triple light rows.

Some gassers object to the older forms of atmospheric burner —a kind of Bunsen—because of the difficulty of accurately regulating and maintaining the best proportions of air and gas to get steady uniform flames. An atmospheric burner may contain a chamber for the admission of cold air so as to increase the heat of the flame, and utilise the fundamental Bunsen principle of obtaining increased heating and diminished lighting effect.

One excellent firm of gassing frame makers can now apply automatic preliminary gas and air mixers in which the proportions of air and gas are automatically regulated at the main supply.

With the former make of atmospheric burner it was alleged that the flame varied, was liable to easily blow out, the flame might waft from under the thread, the air chamber required heating. There was never any doubt about increased intensity of flame being obtainable from the atmospheric burner.

To prevent wafting of the gas flame on a gassing frame due precautions are necessary or "stripy" gassed yarn will result. The opening and shutting of doors, the method of ventilating, the methods of gas and air mixing, are points to watch. Modern methods of supplying the machines with gas and air mixtures have the desirable effects of reducing gas consumption, stiffens the lights, and makes them less susceptible or almost impervious to doors opening and shutting, while giving also more uniform gassing.

Bray's special burners, Dowson's blown gas, and different external machines for gas and air mixing, represent attempts at improvement in the use of gas for the yarn singeing business.

Electric singeing, vertical burners, automatically regulated external mixing apparatus, bottle-shaped creel bobbins, quick traverse gassed cheeses, split drums with yarn picking-up devices, neater and more effective methods of tensioning and guiding the yarn; represent leading items for attention in cotton gassing. Also improved leverages and handles for starting and stopping any one cheese in the case of broken ends, and changing front or back bobbins.

Attention should be directed to the provision of pure and first-hand air to the gassing frames, partly because the drawing of the air from dust or fibre-laden positions soon tends to choke the burners. In any case soda ash water cleaning for bowls and burners may receive consideration.

The main service of gas may be shut off in the case of stoppages for meals, so that the regulating taps may remain set true.

Hard twisted yarns and coarser ones may require hotter flames than fine and soft twisted yarns, and this will mean increased gas consumption for the harder and coarser yarns.

Mem.—Uneven gassing from choked burners and other causes, and extreme discoloration and striped gassing, may often seriously show up after subsequent bleaching and dyeing operations, especially in delicate dyeing shades.

Speeds and Diameters.

Gassing and winding speeds need regulating to obtain the best results. Winding sideways from revolving doubler bobbins require the spindle speeds to average about 500 to 550, whereas in ordinary mule cop winding 1,000 r.p.m. of spindle is often the custom, and twiner cops permit 800 or so. Often slow-speed winding gives better clearing effects.

The standard diameter of drum on the gassing frame is 7 inches, and these could only make possibly 115 or so r.p.m. when winding from flanged clearing frame bobbins.

Formerly it was common to creel flanged warpers' bobbins at the gassing frame, and to wind the gassed yarns upon other and smaller flanged bobbins.

Modern practice dispenses with both sets of up-to-date flanges, the tapered or bottle bobbin going in the creel, and the quick traverse drum winding principle adopted for placing the gassed yarn upon small tubes. In this way quick end unwinding is permissible both at the gassing frame and subsequent reeling. Both the tapered bobbins and the gassed cheeses contain much more yarn, and enable higher speeds, the 7-inch gassing drum making possibly 220 r.p.m., with possibly 130 lights per tenter, and the reel 250 to 300 r.p.m. Much higher speeds drum than 220 are attainable when vertical burners are used, 500 to 600 having been suggested as possible to reach.

Improved types of burner have reduced the gas consumption from about $1\frac{3}{8}$ cubic foot per hour, per light, to less than 1 cubic foot on average lace two-folds.

Latest methods of gas and air mixing and improved burners have still further reduced gas consumption.

Developments.

Modern gassing developments much adopted include: (*a*) Improved gas and air mixing in which more air and less gas is used. (*b*) Improved bowls—sometimes aluminium. (*c*) Bottle-shaped bobbins in the creel. (*d*) Quick traverse drum winding for dispos-

ing the gassed yarn upon flangeless tubes. (*e*) Improved ventilating apparatus for removing the fumes and refuse due to gassing.

Vertical burners, electrical singeing, special thread pick-up devices, etc., are still more ambitious devices whose commercial success is yet somewhat in the future.

When *warp yarns* are gassed and might afterwards need rewinding from gassed cheeses, it is possible to obtain frames which will place the gassed yarn directly upon the ordinary flanged warpers' bobbins of 4½ to 5 inches length and thus save a winding process, unless large cheeses can be made on gassing frame suitable for warping machine.

The Gas.—More usually town's gas has been used, and special apparatus adopted in order to secure the most effective mixtures of gas and air, thus obtaining greater heat and less smoke and flame, besides reducing the gas consumption.

A fault of Bunsen or atmospheric burners is the chance of dirt passing along with the air and preventing satisfactory mixing of gas and air; 5 to 5½ parts of air to one of gas usually gives excellent gassing results.

Modern gas and air-mixing installations are now available, giving both high pressure gas and high pressure air.

Vertical Burners.

To build up good quick traverse cheeses at speeds of 300 r.p.m. or so, becomes somewhat difficult with gearing end cams. Experiments with vertical burners and bottle bobbins in creels have led to the use of the split drum principle, in order to keep up to the possible limits of winding-on.

The drums may be cut in a special way, or there may be special wires in order to quickly pick up the threads in the traverse when ends are started up. 500 to 800 r.p.m. have been reached in tests with vertical burners, split drums, and special pick-up devices. This represents a very high speed for the yarn.

With the end cam and long bar traverse the long bar must be as thin and light as possible to reduce shock at change of traverse. The vertical burner is designed to give sufficient gassing for many cotton threads in one passage, and two passages meets extreme gassing requirements.

The vertical burner is supposed to give more complete combustion of the dust and fibre given off in process. The flame is inside the tube.

On yarns 2/50's to 2/100's these vertical burners may yet develop into a use not hitherto attained. If anything it may be expected these vertical burners will benefit health conditions.

Electrical cotton singeing has been experimented with, but very

little success up to date. Health conditions would be improved with this, but uniformity in singeing so far is not sufficiently good by electricity, but it is reasonable to suppose that this kind of singeing is likely to develop sometime in the future. Cost is greater.

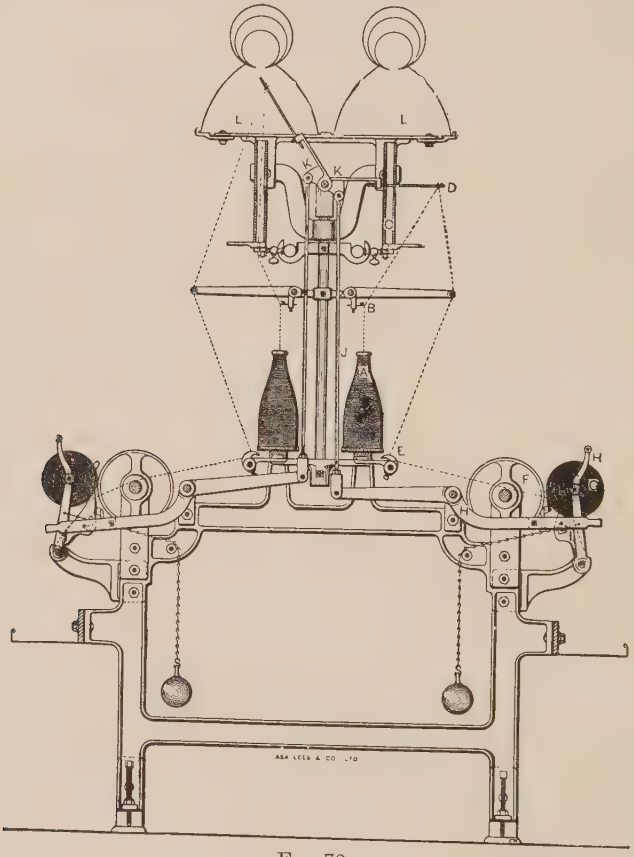

Fig. 72.

References to Fig. 72.

A Taper or "bottle" bobbin.
B Guide wire.
C Vertical burner.
D Top guide wire.
E Tension hook.
F Patent split drum.
G Spool of gassed yarn.
H Starting lever.
I Latch lever.
J Connecting rod.
K Radial lever.
L Dust remover and ventilator.

The gassing frame of Messrs. Asa Lees & Co., containing vertical burners, is shown in Fig. 72.

Also split drums with special yarn pick-up slots arranged for bottle bobbins in the creels.

The ventilator, L, which is only supplied when specially ordered, is fixed over the burners in order to take away the gas fumes and dust. It is combined with a very efficient high-class fan, which is fixed on the gearing end framing and is driven from the driving shaft of the machine.

A patent gas and air mixer can be supplied with each machine, if desired, fixed in the framing of the machine, as shown on page . This apparatus is strongly recommended, as it mixes the gas and air in the exact proportions desired and feeds them to the burners at a constant pressure, entirely independent of the pressure in the main pipe, which may vary considerably without affecting the working of the machine.

A *bottle bobbin* may hold as much yarn as half a dozen cops, and this is a great factor because no process is more harmful in results than gassing, when a frame or bobbin is frequently stopped and started. One such bobbin may contain from 1 to $1\frac{1}{4}$ lb. of yarn when well filled.

Split drums are recommended to wind the gassed cheeses with very high speeds, with special yarn pick-up devices. Most makers, however, of drum winders, have adopted small diameter round or square wire for the long rods of the traverse motions, accompanied by spring or other buffer connections for minimising the shock of the change of traverse.

The gassed cheeses may be made up to 6-inch diameter, and this counts heavily in cross winding for export, meaning possibly 15 oz. of yarn on one paper tube.

Soft Yarn Gassing.

For soft yarns on winders' flanged bobbins, each bobbin may be held at 45° on its spindle which is pulled round by the yarn. This gives the minimum strain on soft yarns and permits soft, weak yarns to come off the creel and be gassed with few breakages. These creel spindles should revolve easily, but some drag may be applied by a zig-zag band round the wharves in and out in turn and having a tension arrangement.

Effect of Gassing on Yarn Strength.

In a specific case of gassing 224's/2, the strength was 26 lb. per lea before gassing, and after gassing the strength was 1 lb. greater, with counts 240's/2. The concentration given to the thread may explain the increased strength, but any want of skill, care, or efficiency in gassing may weaken yarns.

Counts of yarn, character of yarn, amount of twist, number of doublings, surface speed of drums, kind of burner, intensity and size of flame, number of times through the flame, method of winding from the creel bobbin, special efficiency of each part; all these affect the result.

Electric Singeing.

It is stated that on the Continent electric singeing has received much more adoption than in England at the time of writing. Electrical singeing was introduced many years ago, but is not yet much used in England.

The advantages claimed are stated below:—

(*a*) The heat of the electric burner is distinctly greater than the gas burner.

(*b*) The smells and impurities of coal gas are absent.

(*c*) Discoloration is less liable to occur.

(*d*) More uniform heating among all the burners of a frame, which is a benefit both in first orders or in second orders requiring the same effect.

(*e*) The degree of singeing may be varied to fine degree.

(*f*) The rapidly extending use of electricity for driving and lighting purposes favour the substitution of electrical singeing for gassing.

(*g*) One passage of singeing may be regulated to serve for as much singeing as required.

(*h*) Vertical burners being used the yarn is easily threaded.

(*i*) The electric current for the burners is supplied at a low voltage and fire danger is reduced—an advantage which favours the use of electric singeing machines among other machines, instead of in a separate room.

(*j*) There are now burners not made of platinum, but of a special alloy with great heat-resisting properties, suitably enclosed to prevent radiation losses.

As before stated, electric singeing has not much caught on in England up to the time of writing. Experiments did not work out as good as claimed. Cost has been too great.

Vertical Burners.—With the vertical burner the yarn should be kept in the centre of the flame.

Arundel's vertical burner contains eighteen apertures so that for yarns requiring little gassing some of the gas apertures may be shut off, while for coarse yarns the yarn may be passed a second time through the flame.

Economy of gas may be effected with this burner.

Each burner is fitted with a hood connected at the top with a common duct the length of the frame. At the end is fitted a fan,

so that the products of burnt fluff and combustion are carried along the ducts into a special chamber to be deposited in water.

An eminent firm gives the following table of speeds for quick traverse gassing frames, having well-made bottle bobbins in the creels, split drums, and vertical burners :—

8's/2-fold	300 r.p.m.
10's ,, ...	350 ,,
20's ,, ...	400 to 500 ,,
40's ,, ...	500 to 600 ,,
60's to 80's ,, ...	600 ,,
100's ,, ...	600 to 700 ,,

Drums 7 inches diameter. 100 drums = 2½ h.p. including driving of fan.

The whole of the frame above referred to, including creel and side boxes, constructed of metal, to prevent fire damage. The finer yarns may go through the flame more quickly than the thicker yarns.

Ventilation.—The ventilation problem is so serious in gassing-rooms that some firms have done the work in one-storey buildings, and others in top rooms, in order to get top natural lighting, rooms 13 to 15 feet high, and thus to facilitate healthy conditions without interfering with the steadiness of the gas lights. Sheds are best, with fans placed at top of room. Various patented arrangements are available. A gassing-room 80 feet square might serve for 1,800 lights, and require half a dozen top fans with inlets for fresh air from flues placed underneath the frame centres.

In winter the extra use of fans may compel a rather efficient service of steam pipes for heating, in spite of the heat unavoidably obtained from the many gas lights. Possibly cheap running and financial economy may result from using reduced ventilation, with consequent reduced need for steam heating.

Gas and Air Mixing.—In most towns ordinary town's gas is usually convenient and reliable, and is used for cotton gassing after mixing with correct proportions of air. After the war, town's gas in many places was very poor for quite a time.

In the latest air and gas-mixing devices, separate blowers are used both for the air and the gas, there are change wheels to alter the relative speeds and proportions of air and gas. High pressure is used for both air and gas. There is a tank above the blowers, and the tank contains separate water-sealed compartments for air and gas.

At half-lift is the central position for this tank free to take in more air and gas, or to give some out.

Other makes will supply blowers to intensify the gas.

Single Yarn Gassing.—Formerly, gassing usually took place

between spinning and doubling, and this custom still exists to some extent—especially for some kinds of weaving—but now-a-days gassing is more usually done after doubling.

Defects in Gassing.—"Tendered" yarn is produced by over-gassing. "Striped" or "stripy" yarn is produced by uneven gassing. "Gassed perfectly," means *all* the loose fibre removed.

A hard-twisted, wet-doubled "voile" yarn will naturally need different gassing treatment than a single spun warp yarn.

Sewing cotton is occasionally gassed, but much more often it is used "plain" or only "polished."

Gassing principles remaining the same as in 1836, details have vastly improved in respect of: (1) cleaner gas; (2) intensified gas; (3) bottle bobbins; (4) quick traverse winding; (5) aluminium burners to give more heat and less light; (6) vertical burners; (7) improved ordinary burners; (8) removal of fumes and burnt residue; (9) general ventilation.

Electric singeing is still in course of experiment.

Aluminium bowls are perhaps of greatest value in the finer sorts of yarn.

Bowls are sustained in vertical slotted brackets suitable for easy adjustment to the best advantage in the flame.

Heavy bowls, neglect of cleaning same, many times round the bowls and high speeds, impose much strain on the yarn; hence possible developments in upright burners, which are, at any rate, free from these disadvantages.

Formerly, yarn in the gassing frame was wound from one double flanged bobbin, through the gas flame, and then upon smaller double flanged bobbins, and this custom has still its uses; although the more modern method is to wind off bottle bobbins, and upon quick traverse cheeses. Unwinding from revolving bobbins may dispense with the flannel drag boards used when unwinding from twiner cops, or bottle bobbins.

Tensioning.—The "noton" circular cone brush, the steel or glass ball in cone cup, and other methods of yarn tensioning as used on some reels or winding frames; may occasionally be found on gassing frames, but more commonly there are simple flannel-covered boards, or double guide rods.

Flanged Bobbins.—Although the modern quick traverse cheese packages of modern gassing frames diminish doffings by holding more yarn, are better for transit, and permit high speed reeling over the end, there are many who prefer to still use flanged warpers' bobbins, when the latter are to be taken directly to a beaming or warping frame.

Burners.—Very many types of burners have been more or less in use, giving different lengths or widths of flame, admitting a greater or less amount of air economy of gas, adapting burner

shape to crossing outlines of threads suitable for number of times round bowls, or presenting some other particular feature. Burners have been patented asserting to efficiently gas two or three threads at one time, but the writer has not seen them at work, and one thread breaking while another works on presents difficulties to this system.

Piecing-up.—Minimum danger of ungassed portions of yarn passing forward, is obtained when an operative unwinds the thread from the gassed tube or bobbin, works backward with the yarn, and makes the piecings at or near the creel bobbin. This method, however, is not as easy as piecing-up at the gassed tube, in the grooved bowl frame.

In frames containing the modern upright burners, and split drum winding, care should be taken to avoid broken threads from winding round the drum shafts.

A blue flame appears best for thread gassing purposes, giving more heat and less light than a white flame. The true flame is obtained by using a good mixture of air with the gas.

Gas Making.

There are yet districts in which town's gas is not available, but such cases may be met by special apparatus for producing oil gas from almost any of the well-known lighting oils or even other oils or greases.

In purity and efficiency such oil gas will favourably compete with coal gas if well produced.

Details.

Double doors are best suited for gassing-rooms—after the style of house vestibules—one door being closed before the other is opened.

Carbonic acid gas, the smell of burning fibre, the heat of the many lights, the need for steady lights, render gassing-rooms at once the most needful, and also the most difficult to satisfactorily ventilate.

Modern improvements, however, facilitate this ventilation without the absolute necessity of placing the gassing-rooms inconveniently distant from preceding and succeeding processes.

In some modern frames the creels have been brought more towards the front, to obviate the need for operatives reaching across the gas lights.

Speed Limits.

Gassing capacity, ability of yarn to pull grooved bowls round, difficulty of pulling creel bobbins round, impact of cam and traverse rods—have been limiting factors for speed.

Bottle creel bobbins, vertical burners, split winding-on drums, are chief factors for increased speeds.

A double operation of gassing, at moderate drum speeds, is sometimes advisable for coarse, soft, two, three or four-folds. Wages often paid per score of lb. or per 100 lb. weight after gassing.

From productions calculated upon drum speeds, it may be advisable to reduce 20 to 30 per cent. for doffing, creeling, piecing-up, cleaning or other purposes.

A Merit of Two-Headed Bobbins.

Some mills which prepare gassed yarns into ball warps will use slow traverse frames and flanged bobbins to hold the gassed yarn, and will wind off revolving spindles. The winding speed of a vertical spindle winding machine, is rather high for good work in making large flanged warpers' bobbins for beaming.

In unwinding from cross-wound quick traverse cheeses, the yarn makes abrupt crossings when the cheese becomes nearly empty, and yarn breakages may be too frequent. The wide and varying spirals are not good when coming-off at either winding or warping frames.

It is important to have the yarn tension and the crossings as uniform as possible on the warpers' bobbins. Referring especially to yarns for ball warping, gassed yarn is more wiry than plain yarn, and on this account tends more to web or fall off the ends of the cheeses in quick traverse winding. At the next process the plucking at these webbed ends causes yarn breakages, and may result in slack or tight ends in a warp.

When slow traverse winding follows slow traverse gassing, the winding-off is more uniform and steady.

The Lace Trade.

In England this trade proved to be very bad during 1921-22.

Gassing plays an important part in the production of lace yarns and other high qualities of cotton yarns. Cotton gassing has probably improved more rapidly than the gassing of worsted and silk. Gassing burns off loose fibre and makes cotton yarn smoother, more compact, and more lustrous owing to the reflection of light from the body of the thread not being obstructed.

The lace trades of Great Britain, the Continent, and also of Japan have been valuable for very many years.

Single yarns, two-folds, and three-folds have been much required for gassing. Both combed and carded yarns may be gassed. Polishing is preferable for sewing cottons and not gassing.

Dr. Ure about 1836 referred to gassing as being then a valuable business, well established.

Mercerising.

The beautiful effects obtained on cotton yarns and cloth by mercerising, are enhanced in gassed yarns, and mercerising has increased the demand for gassed cotton yarns.

It is much easier to effectively gas a hard, two or three-fold yarn than a soft one because the latter is so easily injured by gassing.

Defective gassing may result from choked burners, variation in intensity or pressure of gas, variation in different lights, of gas force.

Bleaching and pale shade dyeing cannot entirely remedy this.

The type of burner to be used, the pressure and quality of gas that is used, the proper ventilation of the gassing-rooms, possible danger of fire, the amount of twist in the yarn, carded or combed yarns, the percentage of gassing obtained, have always been great points.

Soft Yarns, Creels, and Drag.

Gassing frame creels and yarn tension devices may be arranged to suit the class of yarn.

In the case of gassing frame operating upon soft yarns, the creel bobbins may be placed so that the yarn is very directly drawn from the bobbins at the easiest of angles.

A line drawn right through the bobbin centre might be at 45° angle to a second line drawn horizontally through the centres of the two small grooved bowls.

The soft yarns may then be gassed with the minimum of broken threads.

The path of the thread from bobbin to bowl is such that the yarn wraps round the grooves from left-hand to right-hand when facing the delivery or front of frame.

Exact uniformity of drag is scarcely obtainable when a full bobbin is compared with one nearly empty.

Drag may be controlled if desired by cloth washers, creel spindles must be steady, and gassed yarn spools should fit very accurately in position.

Dyeing.

If yarn is irregularly gassed and yarn is dyed in strong shades some of the irregularity may not be very apparent, but the want of uniformity does show up after delicate shades of dyeing.

Slack Gassed.

Occasionally yarn may be gassed two or more folds wound together without twist, or "slack" gassed.

If such yarns are also "dry" doubled, the single yarn in cop or other form should be thoroughly conditioned.

Skill in Gassing.

Skilful gassing will clear the yarn neatly from projecting ends of loose fibre without weakening the thread by scorching.

Uneven or stripy gassing is not removed by bleaching or dyeing, and yarn is more easily injured in gassing than perhaps in any other process. Many doublers dislike the gassing process and prefer it to be done by the customer.

The gasser has to take careful note of the character of the yarn or thread to be gassed in regard to such features as kind of raw cotton; whether combed or only carded, the counts of yarn, the twist per inch.

Regarding such points as the foregoing he must then pay attention to the speed or feet per minute at which the yarn is wound, the type of burner that is used, the number of times the yarn passes through the light, the intensity of the flame, the amount of drag on the yarn, the kind of creel and creel bobbin required, the amount of drag or tension on the yarn, and the kind of tube the gassed yarn will be placed upon.

The pitch and size of aluminium or brass bowls require some variation according to counts of yarn to be gassed. A light should cover all the crossings of yarn.

The thicker the yarns and higher the amount of twist, the more gassing will the yarn stand.

The intensity or size of flame may be altered by a tap at each burner, or all the lights on one side of frame may be altered by a valve on the frame end. Nearer the meter the whole of the gas supply may be altered.

Double Gassing.

With the modern vertical burners some yarns may be gassed twice, while with bowl gassing it is possible to arrange double or triple burners containing two or three lights, and very coarse

counts of yarn may pass through as many as three lights, using bowls sufficiently wide and possibly $1\frac{1}{4}$ inch larger in diameter and grooves wider apart than normal.

For 100's yarn or finer single gassing, 4 groove bowls may be sufficient giving 9, 7, 5, 3 passages possible, or else 8, 6, 4, according to the creel and yarn threading arrangements.

Seven to nine passages for 2/100's, five to seven for 2/180's or finer, with yarns of usual or full twist single gassing.

Gas Economy.

For business reasons it is advisable to exercise care and economy in the use of gas, and this is aided by a skilful selection of burners.

In cotton mills the ventilation problem is often complicated by the need for air currents not adversely affecting the cotton, the operatives, or the processes; in the ventilation of gassing-rooms the ventilating difficulty is still greater owing to the need for the ventilation not to affect the gassing process lights.

Slow Traverse Frames.

Bottle bobbins have largely superseded twiner cops, flanged winders' bobbins, ring spools, in the creels of gassing frames.

Some firms that do gassing may sell some of the gassed yarn in the form of warps, and these may find it necessary to employ one or more slow traverse winding frames, of either the upright spindle or the slow traverse drum type, to wind the gassed yarn upon flanged bobbins.

The varying pitch of the cross winding, quick traverse cheesing principle is all against good work if ever these gassed cheeses were placed in the warpers' creel.

The crossing pitch or spiral becomes greater as the diameter of cheese increases in drum winding quick traverse.

Uniform yarn tension is necessary in making warps from gassed yarn, and also as few piecings as possible; and hence the virtue of transferring the yarn from gassing frame tubes to flanged warpers' bobbins for the warping frame creel.

The wiry nature of gassed yarn develops the natural tendency for webbed ends on the cheeses or ends run off the edges, in quick traverse winding.

For this reason some firms yet prefer slow traverse gassing to precede slow traverse warp winding when gassed warps are required; and especially some sorts, such as mill warping, which sometimes give a very high speed to the creel bobbins.

Differences between Lace and Sewing Threads.

There is only one way of producing the strongest and best cotton yarns, and that is by spinning single yarns carefully up to more or less fine yarns, and then doubling single threads together so as to produce a coarser thread of the requisite dimensions. Lace and sewing threads are alike in that in each case the finished article must be of superior quality. They differ in that lace cotton, when ready for use, is generally much finer than even the best sewing cottons, and beauty and appearance are perhaps more essential in the lace cotton, while strength is the essential requisite in sewing cotton. In both cases the yarn from the spinning machine may be passed through the doubling winding machine and the doubling twisting machine. The cotton for thread is very frequently sold in the cop to the thread makers, who themselves subject the yarn to all the operations deemed requisite for preparing the thread for the market. For the better kinds of sewing thread the spun yarn may be subjected to the following operations: (1) doubling winding; (2) ring doubling and twisting; (3) re-winding; (4) finisher ring doubling frame; (5) glazing or polishing and winding upon suitable bobbins; (6) spooling or balling according to the market.

About 60's single yarn is very largely used in the production of sewing cotton, while from 100's up to 200's are probably more common for the lace trade. Two-folds are customary for the lace trade, but three-cord, four-cord, and six-cord are more usual for sewing thread.

For the lace trade the single yarn may be put through the doubling winding frame; then through the doubling frame, where the ends are twisted together, and the doubled threads wound upon bobbins. Sometimes the winding frame is dispensed with, and some lace yarn is doubled on the flyer throstle frame.

After doubling, the threads may be cleared, gassed, and picked. In some cases it may be passed through the preparing machine and sorted, and finally reeled and bundled ready for sending to the lace manufacturer. Or the lace manufacturer may purchase the required yarns and perform some of these operations at his own works.

The gassing process is customary for lace yarns, but only in occasional use for sewing threads. The finished lace threads will be usually much finer than the finished sewing threads.

Processes for Glacé Sewing Threads.

The word "glacé" being taken as the equivalent of the word "glazed," it may be said that for sewing thread it is very probable

that the single yarn would be spun either on the mule or on the ring frame as required.

The cops would probably be next taken to the doubling winding frame, which is a machine of somewhat recent adoption, in which from two to six threads can be doubled together, and wound on bobbins or "cheeses" without twist being put in. Occasionally, even now, this machine is not used, and formerly it was usually omitted, and the cops or bobbins taken direct from the spinning machine to the doubling or twisting machine, with both doubling and twisting proceeding simultaneously.

The adoption of the doubling winding machine, however, enables "single" and "corkscrewed" yarn to be much more easily prevented by the means of a specially provided "detector wire" stop-motion, which can be readily applied to such a machine, while it is difficult to satisfactorily apply it to a twisting machine. The threads having been doubled at this machine are at the same time formed into bobbins or cheeses, which are then taken to the twisting machine, this latter usually having its spindles revolving the contrary way to those in which the spindles of the spinning machine revolved. For sewing thread the cotton is often cabled by passing again through the winding and twisting machines. Afterwards the thread may be subjected to a polishing and glazing process, there being one or two principal methods in vogue. Then it may be wound into suitable shape, and finally spooled or balled for the market as required. It may be added that one method of polishing consists of forming a kind of warp or chain out of 360 bobbins. The chain is first bleached or dyed, and then passed through a special size mixture, after which the yarn is subjected to the action of rapidly revolving brushes before being spooled.

CHAPTER XIII.

SIZING.

Sizing of Cotton Yarns.

THERE is no more important process in the cotton trade than that of sizing the yarn intended for loom warps. In a sense, sizing is almost as strictly belonging to a weaving mill as the loom itself, but modern conditions have led to occasional semi-separation of the two in that, in certain districts, the adoption of the room and power system has enabled quite small capitalists to become owners of small weaving sheds, and to share with other small shed owners in supporting more or less independent slasher sizers. Speaking from both observation and experience, slasher sizing does not appear to have very much altered in its main features for sixty years or so.

Period 1880-90, at Messrs. John Wood Bros., Limited, Glossop, the writer worked within a few yards of a slasher sizer, the winding and warping-room being next beyond the slashing, with the drawing-in and the twisting-in room below and looms in the basement.

On innumerable occasions during above period the writer helped the slasher in changing beams, in having a look at the size-mixing becks, and in various odds and ends appertaining to the work of a temporary slasher's labourer. Equally so in regard to winding and warping when taking-in full skips of cops and waiting for empty ones. Zest was given to all this work by the fact that the writer shortly became an evening teacher of both spinning and weaving at such places as Glossop, Hyde, Hadfield, Stalybridge, and Droylesden, before finally settling at Bolton.

Importance of Slashing.

One slasher sizer will prepare warps for several hundred looms, and the ability with which the work is performed, combined with the qualities and kinds of sizing materials used, will make a very great difference indeed to the work of the weavers and the production of cloth.

Glossop and Cheshire printers are comparatively lightly sized —12 to 20 per cent. on the warps, but even this proportion wants strict attention. Shirtings, domestics, drills, and heavily sized goods may be, in a sense, made or marred by the kind of sizing. From personal experience and observation the writer may say that extreme care and watchfulness are at least as important in sizing as in any mill operation, and the work is that of a competent man who usually gets good pay.

Objects and Materials.—100 per cent. or more on the warp yarn is a percentage by no means unknown for some goods.

Objects of Sizing.—Objects more or less aimed at in sizing are :—

1. To impart strength, feel, and polish to warp threads.

2. To cheapen cost of production, and at the same time give a full appearance to the cloth, by adding such weighting materials as China clay to the warp yarn.

In Bolton the author has watched what is termed "dry slashing" for very good yarns and certain good cloths, but for the most part it is necessary to size ordinary cotton warp yarns to make them withstand the chafing and straining actions of reeds, healds, and shedding in the loom.

The tension on warp threads in weaving is considerable, and whilst the threads are fully taut and extended, the healds with their up-and-down action, and the reeds with their to-and-fro horizontal action, rub very severely against the warp threads.

In sizing, a mixture of suitable ingredients is embodied in the yarn, projecting fibres are laid down, the yarn is made smoother and distinctly stronger, so that loose fluffy waste is reduced at the loom, there are fewer warp thread breakages, and the cloth acquires a strength, body, "feel," and toughness which adds to the value.

Appearance and "feel" are also affected by the condition of the non-sized "weft," and certain of the loom settings which may or may not promote "cover" in the cloth.

Percentage of Sizing.

Sizing percentage is not calculated on the weight of the cloth, but on the weight of warp yarn, and this percentage has varied all the way from 4 or 5 per cent. up to almost 200.

Above 50 per cent. may be classed as heavy sizing, 20 to 50 per cent. medium sizing, and below 20 per cent. as light sizing.

Goods intended for the washing-out processes of bleaching, dyeing or mercerising obviously require only such sizing as will help in weaving.

Sizing percentage should be calculated on the weight of warp yarn *before* sizing and not *after*. Thus, if 100 lb. warp yarn becomes 160 lb. by sizing, the sizing is 60 per cent. Calculate

percentage on the 100, not on the 160, and certainly not on the cloth, which also includes the weft.

Strength for Warp Yarns.—It is at least a century old law that warp yarns must be stronger than weft yarns in a general way.

Ordinary warp yarns pass through the operations of winding, warping, and sizing before reaching the loom, and in the loom itself the threads are drawn from the back beams. In addition, at the loom there are the rubbing actions of healds and reed, and stresses due to shedding. Grey weft is simply thrown across the width of the loom.

We have therefore the long-established twist constants of 3·75 for American warp yarn, 3·25 for American weft, 3·606 for Egyptian warp, and 3·183 for Egyptian weft, this constant being multiplied by the square root of counts in each case. Ring yarn often takes rather more twist than above. Warp yarn often needs rather better raw cotton than weft as well as more twist. The softer spun weft is cheaper to spin and gives a better cloth cover.

Excess of twist in warp yarns may resist the impregnation of the yarn by sizing materials, especially in heavy sizing, and this may affect the twist constant in some cases. A good sizing twist is sometimes a bad winding twist yarn.

For the most part strength and elasticity are required for warp yarns, while colour is not important owing to covering up by sizing. On the other hand, softness and colour are often sought in weft, to get cover, feel, and full appearance.

When teaching in Glossop, Ashton, and Hyde, the writer often heard of cloth giving trouble owing to weft cops of opposite twist being used from what was customary. Nearly all single warp yarn is twist way from any cotton, and so is Egyptian weft for the most part. American weft yarn is twisted either way to suit cloth requirements.

Back Beams for Slashers.

The system of having the beam warping machines on the same premises and adjacent to the slashing-room, has not only the advantages of ready transit of beams from warper to slasher, but is also some check on bad back beams.

An evil arising from the modern large business in warpers' back beams—especially from ring yarn—being made in the spinning mill, is the tendency for the spinning mill people to be somewhat careless in the beam warping.

Warpers' beams are made singly, but are used in sets of 4 to 8 behind the slashing machine, and trouble in one beam of a set is bad for the whole of the work.

The woman beamer not taking ends parallel or straight, causes crossed ends, which, when being slashed or taped cause "lappers" and bad smashes. When a taper stops his machine to make a "lapper" good, he cannot usually reduce the steam pressure in the drying cylinders, and it is not uncommon for about 30 yards of weavers' beam yarn to thus become over-dried and the nature taken out of it.

The weaver may be troubled with missing ends and smashes as well as soft warps.

It may be added that the low prices sometimes offered by manufacturers for ring yarn beams, compel the spinner to push ahead with his warping, even a little against quality.

It would often pay both manufacturer and spinner to have back beams a little more costly and better, but reducing the work of slasher and weaver, and getting better and more cloth out.

The writer has often seen empty warpers' beams, with the flanges crooked, or not set the exact width, and the wood barrel damaged, thus increasing the difficulty of making good warps.

One or two small books have been published containing what may be termed "Tips for Tapers."

Modern Size Mixing.

Apart from the nature of the materials used, there is no doubt that the exact quality of the size, when applied to the yarn, is affected by the manner of mixing in the becks, the manner of its distribution from beck to slasher, the methods of stirring and storage, the application of the steam and water, and means adopted to promote and maintain uniformity in the "twaddling" and in the "life" of the mixtures. Accumulations of materials in becks, pipes, and cisterns require strict attention, and there should be efficient cleaning.

Exact size boiling and mixing is as important as a good deal of boiling, mixing, cooking, and storing of many household items.

Addition of new size to vitiated size is often harmful. There should be continuous addition of correct size mixture to maintain the size at a correct height in its box or beck. Valves of one sort or another are necessary, but often either too free or too dilatory in operation. There has been much trouble at times owing to failure in controlling the supply of fresh size, removal of lumps, uniform level, steam supply, density and temperature.

The "Nivling" system recently introduced, ensures a continuous circulation of size through the size box, maintains a correct level of size, and avoids lumpy size.

No float is used or moving mechanism, and an arrangement is

applied to the supply pipe, giving a constant supply of size as required, sending all the time an excess of new boiling size to the size box. Excess over requirements flows through the constant level control and reaches the size storage vessel. Circulation of the size is by gravity and adapted to either light, medium, or heavy sizing.

Any slashing frame in the connection can be changed readily in density of supply. An important Hyde firm have successfully adopted this system.

Mixing Arrangements.

The long-established method has been to mix size in becks, which have been more usually strongly built wooden tanks, fitted with constantly revolving agitators or dashers for regular and systematic stirring of the mixture.

Three or four becks may constitute a set. The becks are connected by pipes and valves and fitted with brass force pumps.

Take one example of four becks, two of them 4 feet square each, and the other two 8 × 4 feet, or three becks each 8 × 4 feet, often also a copper or copper lined boiling pan is used—especially for heavier sizing—fixed in a higher position than the wood becks so that gravity will help in transferring the size.

Starting with number one of the three-beck system the water and flour mixture may be allowed to ferment, but using the dasher. In the second beck the proper density of flour and water may be got, and in the third beck the mixing completed by adding other materials for softening or weighting as desired. Using three or four becks in a set permits the materials to be added at different stages as experience dictates.

American cotton yarns are sometimes tinted the colour of Egyptian yarns in sizing.

Flour may be steeped in water by the fermentation process in water alone, or steeping may be done with the aid of antiseptics. It is considered that one sack of flour of 280 lb. may be used for 40 to 50 gallons of water.

The flour may be steeped with zinc chloride solution in the proportion one sack to 4 gallons of chloride.

Sizing Ingredients.

Sizing materials and sizing mixture receipts are obtainable in practically unlimited and almost bewildering variety. Certainly when a manufacturing firm has proved by experience that certain methods and materials do well, the firm should be careful in altering, without being too conservative. We are concerned here more with fundamental methods and principles.

Potato flour or farina has been very extensively used, as a basis, being usually moderate in price.

(*a*) Assuming about 10 per cent. size we may take the proportions of 100 lb. farina, 10 lb. paraffin wax, 100 gallons of water. If wanted, China clay could be added to above to give more than double the percentage of weight.

(*b*) For heavy sizing, say 90 per cent. or so more and more weighting material must be added, China clay having been long a favourite material. Flour 300 lb., China clay 300 lb., tallow 70 lb., chloride of zinc 5 gallons, chloride of magnesium 12 gallons, soda 6 lb. The flour may be steeped in water for eighteen to twenty-one days. Afterwards the zinc and soda added and the mixture boiled. Other ingredients may now be added and a further boiling take place, such other ingredients having been previously blended and boiled.

(*c*) Medium sizing take possibly 250 lb. flour, 120 lb. China clay, 32 lb. tallow, $2\frac{1}{2}$ gallons chloride of magnesium, 1 gallon zinc chloride, 4 lb. soda. Possibly 80 gallons of water.

Method of procedure practically as above for (*b*).

Equivalent proportions for any desired size of mixing.

As before stated there is a bewildering variety of material available for yarn sizing.

Softeners.—Refined animal fat or tallow is an extremely useful softener but often somewhat dear. A softener such as this prevents the yarn from getting brittle, harsh, and easily broken. Japan wax and paraffin wax are in demand as adhesives and softeners, the latter especially, and which is obtained from mineral oils. Wax may harden a little on the warp with advantage. Soap is also sometimes used as a softener. Other softeners are glycerine, castor oil, Irish moss, cotton seed oil, palm oil, cocoanut oil.

Weighting Materials.—Flour is the first basis of many sizing mixtures, but China clay has long been celebrated as perhaps the leading material for weighting, being a white earthy matter found in various places such as Cornwall and Devon. All lumpy or stony substances are previously washed out and the material then delivered in bags at the mills.

Certain materials are both good themselves at weighting and also help the China clay. We may specify Epsom salts or sulphate of magnesium and Glauber salts or sulphate of soda.

Chloride of magnesium, a mineral salt, is both a weighting and softening material, but the war interfered with its importation from Germany. This chloride will attract moisture, and cause either cotton yarn or cotton cloth to feel damp.

Chloride of zinc will also help weighting, and has the added merit of helping yarn or cloth to resist mildew.

Mildew.—Mildew has before now given much trouble in both yarn and cloth, which may have been stored away for some time.

Mildew rots and weakens either yarn or cloth.

Yarn or cloth conditioned or finished damp and then stored away may develop mildew unless antiseptics have been used, a leading antiseptic being zinc chloride, but others being available, such as sulphate of copper, carbolic acid, salicylic acid, and muriate of zinc.

Mildew may be described as a kind of fungus or vegetable growth which may be killed or prevented from developing by an antiseptic. Excessive economy in chloride use may give great loss in cloth.

Flour has been used when required.

Sizing.

A firm of manufacturing chemists specialising in sizing materials advertise as follows:—

Makers of china clay, sago flour (castle brand), resin size, carbon black, mineral black, French chalk, dextrine, glucose, mineral white glycerine, tinting colours, marking colours, zinc chloride (solid and liquid), magnesium chloride (solid and liquid), Epsom salts, glutina, tallow substitute, cop starch, grip, sizing liquor, blanket liquor, weighing liquor, filling liquor, calcium chloride, farina (castle brand), tallow, wax (all kinds), oils, soaps, rice starch, corn starch, wheaten starch, barytes, cocoa-nut oil, caustic liquor, caustic soda, E sizing flour and sizing machinery.

A firm of sizing machinery makers advertise as follows:—

Size mixing and boiling apparatus; sizing machines of all kinds, with the most recent improvements; drying machines, vertical and horizontal; improved air drying sizing machines, full boiler pressure can be used for heating the air, water returns to the boiler easily; balling machines for sized warps; all kinds of valves, taps, and gun-metal fittings; all kinds of pumps for size and water; centrifugal pumps for water, acid, oil, etc.; special oil pumps; copper and tin drying cylinders; tin, copper, and brass goods used in cotton, woollen, flax and jute mills, and print and dye works.

Slasher Sizing Machine.

Ball warps from the large mill warping machine, hanks of yarn from the reel, and beam warps from the beam warper, each require more or less different methods of treatment and different machinery for the sizing operation.

The slasher sizing machine operates upon a much greater weight of cotton yarn than all other methods put together, but not necessarily on a greater variety of sorts.

Hank sizers, ball or chain warp sizers, dresser sizers, have

gradually given way more and more to the slasher sizer, which is much more productive than any other.

Progressively, the component parts of the slasher sizer consist of a creel for 4 to 8 back beams from the beam warper, the size box, and boiling arrangements, squeezing rollers, 2 large steam heated drying cylinders, drying fans, several dividing rods, measuring roller, expansion reed and finally the delivered weaver's beam and its driving arrangements: (1) back creel; (2) centre drying; (3) headstock front.

A slasher sizing machine occupies a rather large amount of space from the rear warper's beam to the produced weaver's beam. The terms "taping" and "slashing" are interchangeable, the "slasher" having superseded the taping machine used about 1860.

One slasher sizer may serve for 300 to 400 looms, serving more looms for light than heavy sizing, and about 100 looms for one loom overlooker. A 9/8 slasher may make warps 54 inches wide for cloth a few inches narrower, and requiring 60 inches drying cylinder width. 8/4 size takes 84 cylinder width for delivered beam 78 inches between flanges, this being a wide machine. A 6/4 slasher is 66 inches on cylinder, and 60 inches between warp flanges.

The Creel.

Sufficient back beams—4 to 8, often 5 or 6—for such goods as Glossop printers are assembled in the slasher creel, enough to aggregate for narrow goods 2,000 to 3,000 ends in the weaver's beam, usually on two levels. If any back beams are rather narrower than others in order to establish the correct number of ends for weaver's beam, these narrower ones may go at the back to prevent any overhanging of threads. Starting with the ends from back beams the ends meet and combine as each beam is reached, passing over upper and under lower beams.

The assembled warp threads now enter the sow box.

The size box receives size from the mixing or storage becks and passes same backwards to the sow box which may be somewhat larger. Steam keeps the stuff in the sow box boiling.

Midway in the depth of the sow box may be placed two pairs of rollers.

Size Boxes.

The front bottom roller may be of copper and its upper one a heavy iron roller covered with several layers of woollen flannel and cotton cloth. In the back pair of rollers an upper one of iron may rest on a lower wooden roller, the upper roller being covered with flannel and cloth.

There is a copper immersion roller used to alter the depth of yarn immersion in the size by rack and pinion. The assembled warp threads leaving the final back beam position, move along beneath the immersion roller, and thence between the two pairs of expression rollers above described. Deeper immersion increases the percentage of sizing somewhat. The two pairs of expression rollers squeeze away some size and help the other to penetrate the yarn.

The creeling, assembling, and immersing of the warp yarns may be considered as the first of three main divisions of the slasher.

Drying Cylinders.

The yarn now reaches the central or second stage of its treatment. Two large tin or copper cylinders of width to suit the weaver's beams, the back one nearest the back beams possibly 4 feet, and the front one possibly 7 feet diameter, are steam heated at a very moderate pressure, the two cylinders being very well encased in a wood framing. The sheet of yarn passes first clean over the smaller back cylinder without touching and wraps round the larger one, up between the two, then underneath both cylinders to the headstock or front of machine.

This method of yarn passage utilises the maximum amount of cylinder surface and is quite simple. With above diameters a dozen or more yards of warp length may be in cylinder contact at one time.

The yarn has now reached the third or headstock part of machine, and may be immediately operated upon by a pair of fans for cooling purposes. Occasionally by air currents otherwise induced.

The headstock contains rods and reed for separating and loosening the individual threads, the iron rods effecting a division of threads equal to the number of back beams.

Finally the assembled line of threads constituting the completed weaver's warp is drawn upon the front beam, the pull of the yarn from this beam reaching right through the machine. The yarn before this passes round a measuring roller with length recorder attached. Also at the headstock there is usually automatic cut-marking mechanism which strikes and inks the warp selvedge at measured lengths, this helping the weaver in judging cloth lengths.

The Headstock and Front Beam.

Ingenious arrangements have been applied for driving the front beam in the best manner, so that there will be something like reasonable uniformity in winding speed of yarn and to avoid stress and strain on the yarn.

In a long-established method power reaches the chief slashing-frame shaft on which is fixed the driving cone drum. Usually belt transmission from this No. 1 to the second or driven cone drum which may drive by a pinion wheel to a wheel fixed on the friction roller. Clearly the cone drive is intended to diminish the revolutions' rate of weaver's beam, as the latter increases in diameter, the belt moving from small to large diameter of second or driven drum as the beam fills. Apart from this the friction drive permits the slasher to vary his driving tension.

The friction roller is of almost inappreciably greater diameter than the finisher sow box roller, the former driving the latter by long side shaft, the yarn tension being thus eased, but the slight diameter difference preventing a slack line of threads.

Special pressure is applied to the front beams during formation in order to get hard beams, containing a maximum length of yarn, so as to diminish warp gaiting at the loom as well as twisting-in.

Various methods of applying the beam pressure have received more or less adoption.

There may be, for example, one or two rollers held by weighted levers against the under side of the beam.

Slow Motions.

Slow motions are in use for running the frame at a very slow speed to prevent hardening of the yarn during doffing, piecing-up, or other side operations.

The *slow motion* may depend upon the well-known principle—often utilised in ratching or receding motions for fine spinning mules—of having two separate drives to a part, one being faster than the other, and one dependent upon the catch and catch wheel principle. The ordinary driving may have the catch wheel running ahead of its pawl normally, but when the driving power is removed and the catch wheel inclines to stop, then the more slowly running catch or pawl takes the wheel and beam along at an almost stopping rate of speed. Referring to Fig. 73, the driven cone drum here shown receives motion from a driving cone during ordinary working. The catch wheel, A, on driven cone shaft revolves much quicker than the separately driven catch bevel, C, running loose on same shaft. The bevels, B, C, represent one of three pairs of small driving wheels and large driven wheels giving a very slow revolution to catch wheel, C, and the bevel, C, which carries the catch. Transferring of main belt from cone drive to the slow wheel drive would stop the driven cone, but that catch, D, engages with and drives the ratchet wheel, A, the driven cone, drum, and all the parts operated from this cone drum.

Twaddle.—The Twaddle is a kind of hydrometer which has been used for very many years in order to readily ascertain the thickness or density of a mixture of size. Zero on the Twaddle is said to equal a gravity of one. The instrument is immersed in the size for testing purposes.

Immersed in pure water the registration would be zero. Every Twaddle user connected with the sizing of cotton warps must know the different Twaddle registrations he requires for different classes of work.

A specific gravity of 1·005 equals 1° Twaddle.

A specific gravity of 4·020 equals 4° Twaddle.

Tables of specific gravity, of Twaddling degrees, and mill requirements may be available.

Produced Warps.—In sizing, exact Twaddling is desirable, the size should thoroughly penetrate the yarn, the yarn should be rapidly and thoroughly dried without burning, the threads should be well divided and separated, and good, hard beams should

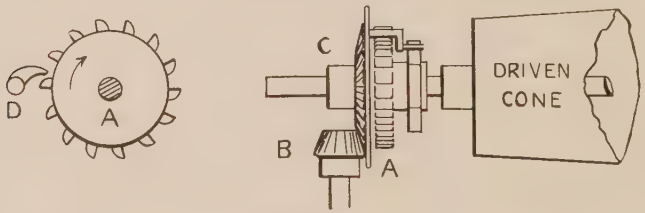

FIG. 73.

be prepared. The warp should neither be too soft, too boardy, nor too stiff. Irregular and rough beams, waste, bad threads, crossed threads, broken threads, and other faults, add tremendously to the work of the weaver.

Cut Marking.—Sizing frames have always been fitted with cut-marking devices of a simple, durable character. This marking enables the weaver to finish a piece when the required length has been woven. For very many years for plain goods the measuring roller h as been 14·4 inches circumference. On end of this tin roller is a wheel which drives through a carrier to a change stud wheel. On same stud is a single worm, driving a bell wheel or worm wheel standardised at 45 teeth. There are measuring motions on this principle on scutchers and bobbin and fly-frames, but in such cases they stop the machines, whereas on a slasher the bell wheel shaft operates a marking cam which gradually lifts a hammer and then suddenly drops the same upon the yarn and momentarily smites the latter against a roller which constantly carries colouring matter. In all such cases we may get the length by placing all

drivens above the line with the circumference of the roller and all driving wheels below the line.

There are other patented forms of marking motion.

Case 1 :—

Measuring or tin roller, 14·4.
Tin roller wheel, 99 teeth.
Driven stud wheel, 55 teeth.
On same stud a worm, 1 tooth.
Bell wheel, 45 teeth.
36 inches = 1 yard.
A pair of mitre bevels may be used also in the train of gearing.

$$\frac{14{\cdot}4 \times 55 \times 45}{1 \times 99 \times 36} = 10 \text{ yards cut.}$$

Change wheels range from 17 to 120 teeth.

Let it be noted that the 45 bell wheel, the 14·4 periphery of tin roller, the worm of 1 and the 36 inches per yard, may be regarded as standardised, leaving only the length of cut, variable tin roller wheel, and driven stud wheel.

From these constants, short rules for lengths of cut or teeth in change wheels are readily determined.

(*a*) Multiply the tin roller wheel by the inches length of cut, and divide by the 14·4 × 45.

This gives the stud wheel.

$$(b) \quad \frac{14{\cdot}4 \times 45 \times \text{stud wheel}}{\text{T.R.W.} \times 36} = \text{length of mark or cut.}$$

Calculations on this principle and tables of the variable factors for certain conditions can be made *ad lib.*

Play may be made upon the fact that the constants

$14{\cdot}4 \times 45 = 648$, and that $648 \div 36 = 18$ inches.

In what is termed a Dhooty marker there may be an extra train of wheels and extra marker. Operated on a similar principle but marking cloth 4 or 5 times or so between the cut marks.

As made by the eminent firm of Howard & Bullough, Fig. 74, shows the ordinary cut marker. At A the measuring roller, B, tin roller wheel, C, stud wheel, D, single worm, E, bell wheel, F, G, mitre bevels, H, the hammer for marking.

The same firm supply extras as specified below if required :—

Yarn Beam Friction.—"Hitchon," with four frictional surfaces, requiring only half the compression on the flannel cloth rings that is required by other makes—needs no readjusting when once the tension is set for a given number of ends.

Two Roller Self-expanding and Contracting Presser.—With this beam presser the yarn is equally pressed right up to the flanges,

no matter how crooked they may run. The selvedge ends cannot be cut, especially when the beam is filled above the flanges. The presser is automatic and requires no attention from the taper when once set.

Traversing Yarn Beam Presser, also *Special Double Roller Presser*, for very wide machines are made when required.

Adjustable Measuring Indicator, "Hitchon," to mark any length of yarn from $\frac{1}{4}$ to 200 yards, metres, or arshines. *This indicator requires no change wheels.*

Improved Triple Bowl Colour Marker.—Makes a single mark for the middle length of piece, and double marks for the "heading,"

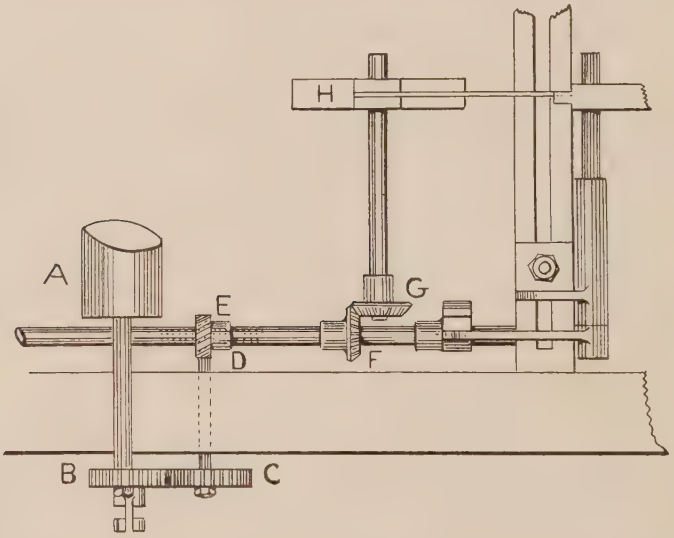

Fig. 74.

or cut marks, the narrow space between the latter being cut through by the weaver.

Dhooty Marker.—Ensures accuracy in the length of marks, and is easily arranged to strike any number of Dhooty marks for one of the cut marker.

Dhooty Sow Box, for coloured yarn, with copper roller, squeezing roller, and the necessary guide rollers.

Friction Driving to both cylinders, used chiefly for fine yarns, to relieve the tension.

Ball Bearings for cylinder pedestals.

Second Sow Roller, of seamless copper, with squeezing roller and driving gear for same.

Lifting Lever for squeezing roller.

Cavity Feed, Float, and Outside Valve, provides for a portion of the sow box being partitioned off and covered in as a boiling box for the size, previous to entering sow box.

Improved Yarn Tension Arrangement (or draw roller) to size box, by which the yarn is relieved of undue strain on its passage through the size.

Expanding Zig-zag Wraith, with motion for raising and lowering the warp; entirely mechanical in its action and not dependent on springs for expansion and contraction.

Second Dead Weight Safety Valve.

The Sizing of Cotton Yarn in Hank Form.

A certain amount of hank yarn is subjected to the sizing process, but an infinitely less amount than slasher beam sizing. A hank sizer is a comparatively small and simple machine since it does not make beams or convert the yarn into any other form of make-up.

Naturally, the central feature of the machine consists of a sizing beck or becks, arrangements for supplying the beck properly with the sizing materials, for holding the hanks of yarn, and two revolving rollers. The properly knotted hanks are placed upon the revolving rollers and have their lower ends in the size mixture. After a short treatment of this kind the knotted hanks are transferred to a pair of hooks, one of which is given a few revolutions so as to wring or twist the yarn and squeeze out surplus size, after the manner in which a woman may wring clothes from a wash-tub. For drying purposes the hanks of yarn are suspended from poles in a stove. In some cases single sizing may be sufficient, while in other cases the hanks of yarn from the first beck, after being wrung out, may be placed in a second beck and exposed to a double sizing effect before stoving. The second sizing may show a denser Twaddling or thicker size than the first.

Sometimes hank sized yarn is afterwards treated by a stretching and brushing machine so as to loosen and brighten the yarn and improve its subsequent winding and warping operations. In this case the stretched hanks may be brushed by reciprocating flat brushes working on both sides of the yarn.

Some hank stretching arrangements simply stretch and shake without brushing, taking the place of hand stretching by a hand roller and knotting hook.

It is not all hank sizers who prefer to use stove chambers for the drying of sized hanks. It is the custom in some cases — especially for the more delicate yarns—to adopt reel or air drying.

The sized hanks are opened out and placed upon the bars and rods of machine, having a good general resemblance to a reel of extra large diameter. There may be the usual six external staves, and also a corresponding number of staves or rods running parallel near the reel centre. Outside and inside parallel rods and staves are sufficiently far apart to hold the stretched hanks. One end of each knot or hank is placed over the inside rod and the other end over the external rod or stave.

Both sets of rods or bars are loose and each reel possesses two sets so that one set of bars may be dressed with hanks while the hanks on reel are being revolved, and dried by circulation through the air.

Compared with slasher sizing for cotton yarn, the hank sizing method is more of a bypath to meet special cases where yarn has been put into hank form for transit or bleaching and dyeing purposes.

Tape Dressing.—The original tape dresser preceded the slasher sizer, and is still occasionally used for light fabrics in Scotland and elsewhere.

Back beams placed in creel as desired. Assembled sheet of total threads passed through a separating reed and then through the size receptacle. Emerging from the size the warp sheet is operated upon by revolving brushes, and dried by a fan and possibly also a small cylinder. The required dividing rods and reed are used to split the threads before winding on the beam. The term Scotch dressing for this kind of work is sometimes used in Bolton, being done along with Scotch dresser sizing, in which each ball warp is coloured and sized as wanted and then combined into weavers' beams on the Scotch dresser.

Dry Slashing.—There is an operation occasionally performed in some Bolton and other mills and going under the name of dry slashing; used for some light fancies. The warper's beams are assembled in the back creel as for slasher sizing. The ends of the several back beams make contact and are assembled into one combined warp sheet, and passed forward to leasing rods, measuring rollers, cut marking mechanism, separating and expansion reeds, much after the manner of the slasher machine, but omitting the central features of sow box and steam cylinders.

Finally, the beam for the weaver is built up on much the usual lines, and apparently the one object of this so-called "dry-slasher" is to properly combine sufficient warper's beam into one weaver's beam.

Take, for example, high-class fine voiles, as made in certain Bolton mills. Warpers' beams of 2/100's and finer are assembled in a back creel after the style of ordinary slasher sizing.

Such two-fold yarns, however, do not need sizing for strength

purposes, nor is it good for some colouring processes which sometimes possibly follow weaving.

A dry slasher, therefore, has no size boxes and no steam-heated cylinders. The aggregate threads from the several warpers' beams are assembled into one sheet, suitably reeded and leased, and finally wound as one warp for the weaver.

A fine clear thready effect is a distinctive feature of voile cloths, and to help in obtaining this, each end is separately dented in the loom instead of the more usual method of two ends per dent in the reed. Fine reeds, possibly 100 ends per inch, and some voile cloths wide enough to require 6,000 ends in the weavers' warp.

Voile effects may run up to 2/150's fine yarns, and become known under the name of "georgette" cloth.

Ball Warp Sizing.

The huge circular warping mill for producing ball warps, or a long loose rope of assembled threads, which may be then made into a large ball, often precedes what is termed ball sizing. This process suits certain classes of work very well and retains a long-established position in the trade.

The loose rope of assembled threads may be conducted through a long sizing trough or vat, at the bottom of which are 7 or 8 rollers under and over which the yarn passes until the desired sizing percentage is obtained.

Emerging from the sizing vat the warp passes round possibly a dozen steam heated cylinders of about 24 inches diameter, which flatten and dry the threads.

Finally, the assembled threads are flattened out, properly divided out and leased, and wound on the weaver's beam in manner well-known. Balling, warping, and beaming subsequent to sizing greatly reduce production and add to cost of ball sizing as compared with slasher sizing.

For some kinds of work, however, it is yet retained as the most suitable.

The yarn may be got into the best condition before making the weaver's beams; there is little or no risk of browning, over-drying, or over-straining the yarn; the process is suitable for short warps, and the warp may be sized twice if desired.

The Yorkshire Dressing Machine. Coloured Goods Trade.

Coloured warps may be dressed, prepared, and placed upon weavers' beams, in this machine, without any sizing being done.

The ball warps of different colours or kinds are placed in suitable receptacles near the machine front.

The machine may be divided into two parts, the chief one being the headstock containing the weaver's beam and the tension rollers.

The second part consists of a framing containing guide rollers, the whole of which may be placed any desired distance away from the headstock so as to give any length of extended warp sheet for hand-dressing purposes. Comparatively small in amount, Yorkshire dressing has been affected by a trade union, is rather costly, and is avoided when convenient.

The ropes of threads are threaded around sufficient of the highly placed round tension rods, assembled in parallel order, and the warp sheet taken overhead to the extension creel and framing. The warp sheet is then brought back in a lower position to the lower front of the headstock containing the warper's beam. The extended sheet of threads is carefully opened out, dressed by hand-worked brushes, properly leased, and then wound on the beam.

The beam is very slowly rotated by power driving, in which a belt works upon the required diameter of a 3-set speed pulley arrangement, and then by a small wheel driving a large wheel fixed on the beam shaft. This is not a sizing machine, but there is a brushing effect.

A long rod extends parallel to the warp so that the beam can be wound in small amounts to permit of proper dressing as required.

The machine is suitable for treating ball warps which may have been dyed separately in different colours so that stripes will be formed in the shirtings or other cloths by the warp. One of the supports for the weavers' beam at the headstock may be moved for different widths of weavers' beams. Two or four ends may be dented together in the reed moved about by the dresser who must also see to the proper warp tension. The production depends more than usually upon the operator, but possibly thirty looms may be served by one machine.

There is no resemblance between the slasher sizer and the Yorkshire dresser excepting that both build up weaver's warps.

Twisting-in, Looming, Drawing-in.

18,000 to 25,000 yards length may be contained in one warper's beam, and possibly 450 to 950 yards, length in one weaver's beam, but beam lengths naturally depend a good deal on the fineness of the yarn, the hardness of the beam, and the initial and final diameters.

After leaving the sizing process the healds and reed must be attached to the weaver's beam.

On some goods such as Glossop printers the same method of drawing-in the ends per inch and other items sometimes remain

the same for long periods. In such cases of using the same healds twisting-in is resorted to. The ends are not tied.

The operative exercises a special twirl of the fingers and pieces each end on the new beam to its corresponding end on the old beam, sitting between a stationary frame-work which holds the parts concerned conveniently.

Payment so much per 1,000 ends usually.

Hand twisting-in is almost the stillest mechanical job in the mill, and this has often led to lame persons taking up the work, which in any case is somewhat tedious.

For twisting-in the operator may have the healds on his left, and the new beam on his right.

Drawing-in is rather more complicated—especially so in regard to fancy cloths requiring variety in the order of drawing the new ends through the healds. The healds of course are used to lift and depress the threads, according to the pattern required, while the reed separates the threads, keeps them in straight line, and helps greatly in the bealing up the weft to the woven cloth. Even on plain work a drawer-in has a higher pay rate per 1,000 ends than a twister-in.

Automatic warp tying and warp drawing-in machines of great ingenuity have become rather largely used of recent years. Such a machine in good order is beautiful to watch and is capable of tying—not twisting-in—up to half a million ends per week of 30's twist, if kept in good order and supplied with good yarn well beamed. The author has watched this operation with great interest.

A man and a boy in attendance on one machine.

The new warp and the remains of the old one are clamped to form two corresponding sheets. The machine will select the individual and corresponding threads from new and old warps and tie them together, making knots of uniform size, with ends automatically cut off. The machine may be adapted to a good range of counts and sorts of yarn, and also to differences in width of reed and reed dents per inch.

The machine is necessarily an instrument of precision, and, if necessary, makers will arrange for experts to call at mills to see if in perfect order.

Slasher Sizing.

In a case coming to the writer's notice great trouble was caused by frequent recurrence of very soft selvedges at one side of each weaver's warp.

After much investigation it was finally discovered to be due to the size entering the sow box all at one side. Semi-cold size

frequently entering at this point often operated on the selvedge ends in an insufficiently boiled and smooth condition. Re-fitting the pipe for entry of size near the centre of sow box on slashing frame quite remedied the evil by guaranteeing the selvedge size to be in good condition, and it is these selvedges which need strength and quality the most.

In a second case there were often complaints of bleaching and finishing processes discovering slightly yellow portions in the woven cloth. Finally proved to be due to drops of cylinder oil occasionally passing into the size from small engine used to drive the slasher and exhaust steam used to boil the size.

Cloth Singeing.

It may be noted that cotton cloth is sometimes subjected to singeing as well as cotton yarn.

Just as loose fibre is burnt off cotton yarn in gassing, so also is loose fibre or nap singed off cotton cloth of some kinds. Either gas flame or heated plates may be used for cloth singeing. In one arrangement the cloth is passed over heated plates, so as to singe one side, then passed over a second pair of plates to singe the other cloth side.

Whether singeing be applied to yarn or to cloth, it is necessary to be extremely careful in order to obtain uniformity of results. In either case the work is sometimes rather disagreeable. A late student of the writer's has done this work for years at a Bolton cloth bleaching firm.

Singeing by gas may be rather quicker than by plates, but is not considered quite as uniform by some persons. One man for cloth singeing appears sufficient for an average size bleach works.

CHAPTER XIV.

NOVELTY OR FANCY YARNS.[1]

Kinds of Fancy Yarns.

Dyed yarns of every description are used to produce ornamental effects in woven or knitted goods.

Lustre in yarns is obtained by combing, preparing, gassing, mercerising, and polishing.

Grandrelle effects are produced by doubling two or three differently coloured yarns together.

It is possible also for yarns to be printed in different colours. Grandrelle yarn is very much used for tying up reeled yarn, being strong, readily obtainable in desired colours, very distinctive, and easily made on any plain doubling frame.

Grandrelle is scarcely a novelty yarn.

Mixtures of cotton, wool, silk, linen or other fibres may be used to produce special effects.

Cotton spinning and doubling mills for the most part find business in fancy yarns very fluctuating in demand, orders being usually of very moderate size, besides needing very special attention. For all that, satisfactory orders do sometimes come along.

Strictly speaking, what are known as fancy or novelty yarns are obtained by using special mechanism for obtaining special effects on single or doubled yarns—perhaps more often in the latter—since greater variety and scope are obtainable in doubling.

Nepped yarns, flake yarns, knicker or slub yarns, knop or knot yarns, corkscrewed, spiral, snarl, and loop yarns are the best known. Gimp yarns have been much in demand during 1921-22 for sponge cloth and other goods

The general term "spot" yarn may be applied to several of the above.

Nepped yarn has its foundation laid at the roller and clearer carding engine.

Slub or flake yarn may be obtained either at spinning or doubling frames.

Most of the others require either a special doubling frame or

[1] Edmund Whittakers of Oldham and Greg Bros. of Stockport, are noted makers of novelty yarns, but many firms produce a moderate amount.

special mechanisms applied to an ordinary one. Spotted and novelty yarns of almost all descriptions find a market in various kinds of ladies' skirtings, dress pieces, coatings, or even blouses in the finer spottings.

Flake Yarn, Broken Wheel Method. Spinning Machine. Intermittent Drive.

Flake yarn is a species of "spot" or "slub" yarn in which the spotting material is very soft and is given to the ground thread in detached portions or tufts.

Fig. 75 indicates a special arrangement which could be

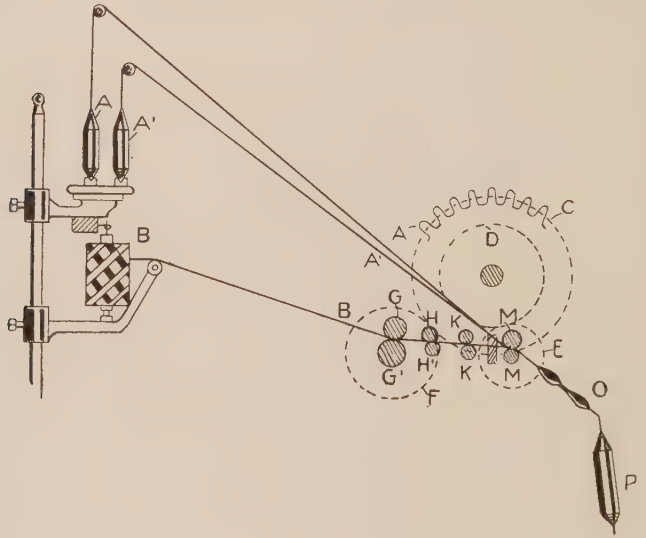

Fig. 75.

adopted in the rollers of either a mule or continuous spinner, either for cotton or wool.

In this case there are four lines of rollers of which the front line at M′ drives the back line as shown by the four draft wheels, E, D, C, F.

The large wheel, C, takes the place of the usual draft change pinion and drives the back and middle rollers only when the teeth are in action. The ground threads, A, A′ pass through a guide, and only the front line of rollers, and are continuously delivering yarn in an undrafted condition. The roving of flake material of any colour or thickness is only fed forward in soft tufts, which simply

twist round the ground threads. The teeth are absent or present on the periphery only to the extent determined upon, either in number of teeth or number and size of intervals.

The bobbin, B, could be of any colour or colours required. Any sort of cops or bobbins could be used at AA′, as desired.

An ordinary ring spinning frame could be adapted to do this work by breaking teeth out of the change pinion, rigging up suitable creels and guides for the cops or bobbins, using only three lines of rollers.

A large change wheel drives the flake sliver in more rapidly. Teeth left in the change wheel at two or three places would give closer spots or flakes. Many teeth left in together give long flakes. Middle rollers driven from back. Either ring-frame or mule. First, second, and fourth wheels contain full teeth as usual.

It is the involved principle that needs most to be understood, viz.: Continuous supply of already spun and twisted yarn through front rollers only, combined with the intermittent supply of soft material.

Flake Yarn, Catch Wheel Method. Intermittent Drive.

A fancy doubling frame may be definitely equipped to produce flake spot or clouded yarn of various characters and colours.

An ordinary doubling frame could have extra rollers and mechanism applied in order to produce flake yarns.

On a doubler for this purpose, there are two lines of rollers in use and two sets of threads. In a typical example there may be two reasonably fine ground threads properly guided and passing through the front or delivery pair of rollers only to form a strong foundation thread. Any colours desired.

The flake or "effect" may be obtained by using either one or two cotton or wool soft slubbings of suitable colours. This "flake" material passes through both lines of rollers, but the back rollers are only turned intermittently in regulated intervals and amounts. The spot or flake is much better fixed if the yarn is redoubled the opposite way with a fine thread on an ordinary doubler.

The intermittent operation of back rollers feeds the slubbing forward in detached tufts.

The vibrating bar which is so useful in knopping, is not essential in "flaking" or "clouding."

The back rollers are driven by four wheels similar to the usual four draft wheel connection, but only by means of a catch and catch-wheel arrangement compounded with the first wheel of the four, and intermittently moved by a cam and cam lever connection.

The levers are operated by a cam compounded with the final wheel of a train of four wheels driven from the lower front roller.

The double carrier wheel may be varied in number of teeth to give a different speed to the cam, and thus to place the spots closer or else farther apart.

The length of flake or spot may be varied by re-adjusting the connecting rod in the long slots of the levers for moving the catch wheel. Both bottom rollers 1½-inch diameter.

Slub Yarn.

Spinning slubs or fancy yarn may be defined as soft, thick, undrawn portions produced by: (*a*) frequently, automatically, and regularly speeding up the back roller, or (*b*) frequently and automatically stopping the front or delivery roller.

Such spinning slubs may be produced either on the ordinary ring-frame or ordinary spinning mule, by the application of special mechanism.

Doubling Slub yarn may be also produced on the doubling frame by twisting thick soft yarn or roving, along with ordinary twisted ground thread—either single or two-fold.

The thin and thick materials may pass through different pairs of rollers.

The cheapest slub yarn is produced directly on the spinning machine with only one yarn as first described.

Knops are also thick places definitely produced on yarn—more especially in doubling—but are usually of a harder nature than slubs. A knop consists of one thread twisted round another one, while a slub yarn may be all the same yarn with soft places at regulated intervals—although it may also consist of one thick soft thread twisted round a thinner one.

Simple Slub Yarn.

Slub yarn may be produced in the single on any spinning machine, as distinct from a doubler. There are mainly two essential methods of doing this, apart from questions of mechanical detail.

Method I.—Drive the front roller of a ring-frame intermittently, while the back and middle rollers revolve continuously.

Method II.—Drive the back and middle rollers at two speeds, one of which only operates intermittently—just when a slub is wanted—and drives the back and middle rollers faster than the normal speed from the other drive. In this latter method the back roller may be driven from the usual four draft wheels, but the back roller wheel is loose on its roller, and is compounded with a catch through which a ratchet wheel secured to the back roller, is driven.

Elsewhere a loose lever is fulcrumed on the back roller (or

other convenient centre), and every so often is moved either by a back shaft connection or else by the travel of carriage, so as to push the back and middle rollers more quickly forward, to produce a slub effect on every thread. By either method the roving is bunched up momentarily between the front and middle rollers, to a definite extent, at controlled intervals, but not sufficiently to seriously impede the ordinary twisting and winding-on operations. The projections thus formed on the threads give a special effect in certain classes of woven goods.

There has been trouble in spinning slub yarns on this basis, owing to want of very exact and uniform operation of the rollers in stopping and starting the slubbing effect.

Mule Slub Motion. Two-Speed or Variable Speed of Back Roller.

In this example the back draft roller is driven from two independent sources.

For the first drive there are the ordinary four draft wheels in the ordinary manner, with the single difference that the B.R.W. is not fast on the back roller but fits loosely thereon, and carries a click or catch.

A catch or rack wheel is secured to the back roller, and is driven by the catch for ordinary drafting purposes.

The above drive is at the headstock.

At the mule end there is a second or supplementary arrangement for driving the back roller from the front. There is a driving wheel on front roller and a driven wheel fast on back roller, with a single carrier wheel connecting them as required.

The carrier is sustained in the arm of a lever which is centred on the front roller, so that said carrier is always in gear with the wheel on front roller, but only intermittently with the wheel on back roller.

The lower and longer arm of the carrier wheel extends into the path of a stud wheel or cam wheel driven slowly round from a smaller wheel on the back shaft. The stud wheel may contain any suitable number of studs—say three, four or five, and each stud in turn forces the carrier wheel lever along so as to temporarily gear the carrier with the special back roller wheel. This drives the back and middle rollers at much the same speed as the front roller, proportionately arrests the roller drafting and in this way forms slubs or thick places in the yarn. As each stud leaves the lever, a strong spring disconnects the wheel.

The slubs are of controlled size and occur at controlled intervals. With eight studs acting per stretch of 64 inches the slub spacing would be 8 inches, using no winding roller delivery motion.

The driving of the back roller by means of the catch and catch-wheel method at the headstock, permits the catch wheel to free wheel away from the catch every time a slub is formed.

The size of each slub is affected by the relative sizes of driving and driven wheels on the slubbing motion.

This is the simplest kind of slub effect, easily produced on a spinning mule, using ordinary single or double roving, just as in making an ordinary spun thread.

Shaper wheel for cop thickness, weights on counter fallers, change pinions for counts, and twist wheels, will be specially regulated as required. The middle roller is driven from the back roller in the usual manner.

Such a motion could be applied to an ordinary ring-spinning frame, but would require the cam wheel or stud wheel to be operated in some special manner, such as by yet a third wheel gear driven from front roller, instead of the third gear being driven from the back shaft as above described. A click arrangement on back shaft permits its running-up reverse turning.

Instead of the spur wheels going in and out of gear it would be possible to have a box clutch or friction clutch on back roller, to be opened and shut as required.

In yet another method a second click wheel on back roller could be operated by special levers.

Second Principle in Slubbing Motions. Intermittent Rotation of Front Rollers.

Below is described a slubbing motion which differs both in principle and construction from the one first explained.

This present motion is specially applicable to a ring-spinning frame, and has distinctly different mechanism from the mule arrangement.

It differs essentially in principle in that it intermittently stops the front roller instead of accelerating the back and middle rollers.

By intermittently stopping the front roller, the slub is not affected by any draft between back and middle roller. Stopping the front roller in this way may possibly have some effect on production, but the spindle is twisting the yarn all the time and production may be brought back by using a larger twist wheel.

A uniform slub is produced, elongated to suit the weaving processes with thinner ends, and at a pitch varied from $\frac{1}{2}$ inch up to any distance practice might require, say up to 80 or 90 inches. The mechanism of this ring-frame motion and of the mule motion first described may be applied to existing machines, and may either be utilised, or if required, put out of gear and the machine worked for the ordinary plain yarn.

In this ring-frame slub motion the ordinary small front pinion is compounded with the large front roller driven wheel, which receives motion from the frame end twist and roller gearing. These two wheels now run loosely on the front roller, and the large driven wheel is compounded with the driving half of a face clutch. The driven half of the clutch is mounted as a sliding fit on a sunk key.

Slub Yarn Motion for Ring-Spinning Frames.

This is made by Messrs. Dobson & Barlow (Fig. 76).

Key on front roller end. There is a lever and spring for opening and closing the clutch, and there are so-called slub wheels containing inclines which operate said lever and open the box as per kind of slubbing effect required. The spring holds clutch in gear. Means are provided for regulating size and pitch of slub.

Operation of Slub Motion (Fig. 36).

The 20's and 70's front roller wheels are compounded together and run loose on the front roller. The front side of web of the 70's wheel is provided with a "face" clutch which drives, intermittently, the front roller driving clutch mounted as a sliding fit on a sunk key on front roller end. The intermittent motion of the clutch, K, is derived from a combination of the train of wheels, F to H, and the lever, L. The wheels, F and H, are made with a groove round the face of the rim into which snugs of any length (depending on length of slubs) may be secured. These snugs are inclined on leading side to ensure easy motion. It will at once be seen that the screw, M, which is set to come into contact with the snugs, J, may be either in slot as shown at M or at M_1, depending entirely on pitch of slubs. When the screw is in slot, M, then the time taken for each snug to pass the screw, or the distance between each pair of slubs is a maximum, on account of the reduced speed of the snug wheel, H. Of course, the change wheel, G, may be altered to give any variety. If the slubs are required to be at very short intervals, then the contact screw must be inserted at M_1 and the snugs in wheel, F. The illustration is, we think, sufficiently lucid as to require no further explanation.

Corkscrewed, Spiral, Gimp.

There is a more or less close relation between chain, pearl, gimp, spiral, and corkscrewed yarns, just as there is between flake, slub, and knop yarns.

Snarl and loop yarns constitute the third broad division of fancy or novelty yarns.

Corkscrewed yarns form a base for modifications, which produce effects to which the more special names are applied.

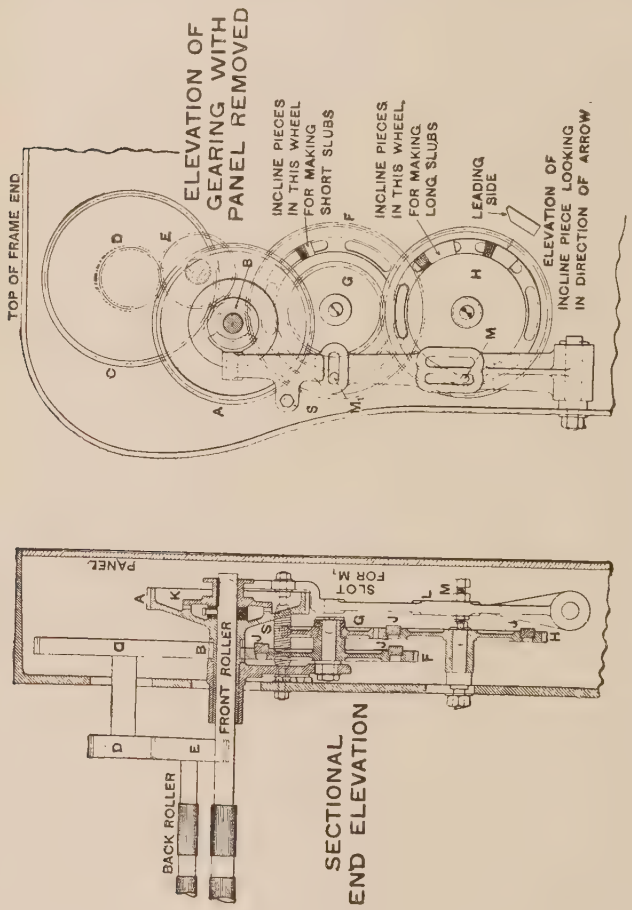

FIG. 76.

References to Fig. 76.

A Front roller wheel 70 T twist and 75 T weft frames.
B Front roller pinion 20 T and 16 T.
C Crown wheel.
D Draft wheel.
E Back roller wheel.
F First incline or slub wheel.
G Change wheel for regulating length of, and distance between slubs.
H Second incline or slub wheel.
J Inclines.
K Clutch for driving front roller.
L Lever for operating clutch.
M Contact screws between lever and inclines or snugs.
M_1 Contact screws between lever and inclines or snugs.
S Spring for holding clutch in gear.

The true corkscrew type of yarn is fundamentally dependent upon the doubling and twisting together of fine and coarse threads in greater or less extreme degrees of counts and twists; with the character of corkscrew developed also by class of each yarn in regard to such features as twist per inch; kind of cotton; dyeing, bleaching, and mercerising; and tension of each yarn. Some effects may result from whether twisting at any stage is done twist way or weft way.

It is fundamental that a fine thread will wrap more or less slackly round a thick one when both are delivered together at the same rates of speed. This principle carried to the extreme of delivery on thread much quicker than the other, would develop the snarl or loop yarn. In coated yarns one or more covering threads are wrapped spirally round the base yarn.

Spiral effects may be obtained from twisting together an effect end and a ground end, the ground end being thinner than the effect end. A spiral yarn may be a very well twisted many-ply yarn. A spiral or gimp yarn may represent an extreme development of the corkscrewing principle.

Always in doubling it must be understood that every doubling twist adds a twist to any single component yarn if twisted the same way, or removes a twist from a single component yarn if the doubling twist is the opposite way to the spinning twist. If a weft way yarn were doubled with a twist way yarn, one of these two individuals would be increased in twist and the other correspondingly untwisted. This factor has always to be remembered in the doubling trade, as it exercises considerable influence on the doubled product.

Fancy Yarn Doubling Frame Principles.

This machine is specially built and equipped for producing fancy or novelty yarns, and almost any type of such yarn may be obtained by adapting the speeds to requirements, applying or putting in gear, the particular kind of accessory mechanism required, disconnecting others that may not for these yarns be needed, using the correct combination and character of "ground" and "effect" yarns.

Underlying general principles of the special mechanisms and effects are as follows:—

1. Intermittent driving of back rollers for flake or thick, soft spot effects.

2. Two-speed driving, or variable driving of back rollers for "slub" yarns. Sometimes by intermittent driving of front rollers.

3. Vibrating bar or bars to alternately tighten and slacken the "effect" yarn in producing knopped or node yarns.

4. Grooved rollers to give tight ground threads and very slack "effect" threads in making looped or snarl yarns.

The first distinctive feature of this short, strongly built machine, consists in 5-speed pulley drive for the tin rollers and spindles, giving a wide range of speeds, suitable in the quick sizes for finer yarns and higher twists per inch, while the small driving and large driven pulleys give the low speeds needed for thick, soft materials and small twists per inch.

A second distinctive feature consists in the choice of various special mechanisms for driving the back pairs of rollers in an intermittent manner or at variable speeds to produce various loop or "spot" effects on the yarns.

Also for combining yarns delivered, some more quickly than others.

A third feature is the use of vibrating bars or faller wires for producing knop effects. Arrangements are provided for quickly gearing or ungearing the motions as desired.

Such a frame will produce various types of "novelty" yarns, from cotton, silk, woollen, worsted, or mohair, in very large ranges and variations.

Each side of the frame may be separately driven by 5-speed cones to allow of different spindle speeds on each side at the same time. Each side may have its own copping motion to give either the ordinary doubling parallel build or the mule cop shape.

The machines are well established and proved in chief principles, but improvements have been effected in cams, cut wheels, variable, and intermittent motions.

All the ring doubler features sometimes wanted, such as wrought-iron ring plates, steel lappets, anti-friction bowls, and adjusting screws for the pokers and rocking shafts.

Ring Doubler. For Plain and Fancy Yarns. (*Messrs. Platt Bros. & Co. Ltd.* Fig. 37.)

Fitted with motions for making all kinds of plain and fancy yarns from cotton, wool, worsted, mohair, silk, etc. Double girder spindle rails. Patent flexible doubler spindles with knee brake. Each side of machine driven independently of the other, with fast and loose pulleys and 5-speeded cone pulleys to vary speed of spindles as required. Cop or conical building motions for wood bobbins and paper tubes, or parallel build for double ended bobbins. To calculate length, multiply half the number of spindles by the distance, and add 3 feet 11 inches if 30½-inch buffets; if with 3 or 4 lines of rollers, etc., for fancy yarns, add 4 feet 11 inches. Width of frame, 4 feet 4 inches. Pulleys, 9 to 16 inches diameter,

3 inches wide. Speeds, 600 revolutions for plain twisting, 480 for fancy twisting.

The character of spinning machine for slub yarn materially

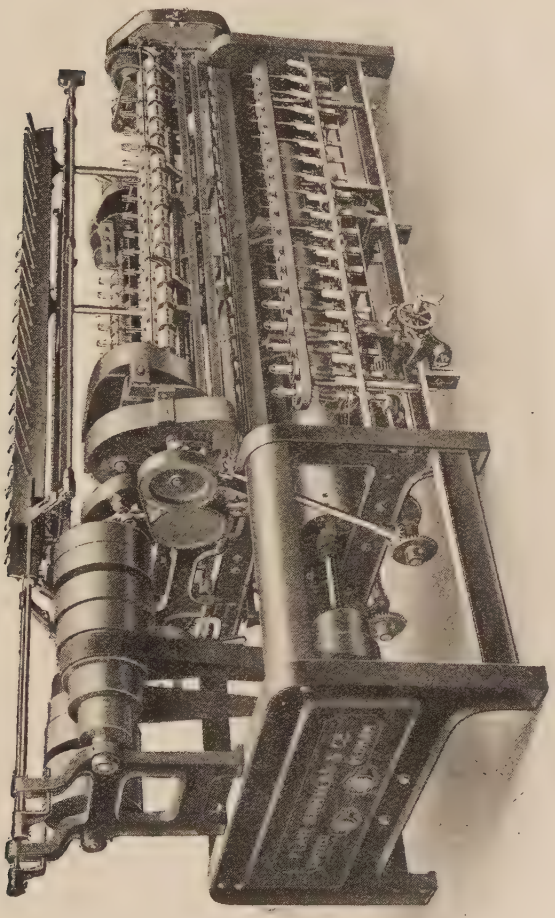

Fig. 77.

differs from that produced on a fancy doubling frame in which intermittent or variable feed or delivery is helped by twisting threads of much varying character together.

From the doubler the simplest slub effect may be obtained by the continuous twisting together of a fine thread with a thick roving, but if in different colours this may be more like a grandrelle thread than a slub.

Fancy Doubling Frame. Slub Yarn. Two-speed Motion. Variable Roller Speeds.

Spot or slub yarn of various kinds may be produced on the fancy doubling frame, by using two or more pairs of rollers, and two threads or two sets of threads. Very special effects may be obtained by different colours, counts and twists.

In a specific case two well twisted ground threads may pass together through a suitable guide eye and between the delivery or first pair of rollers only. Thence through the thread-wire and upon the bobbin.

A softer and thicker sliver of any colour, and either cotton or worsted, is separately passed between *both* pairs of rollers.

The back or second pair of rollers is driven from the first pair by four wheels at the out end of the frame, using a click and click wheel after the style of the four draft wheels in the mule motion.

Also from the front roller is driven a cam wheel, and the cam operates a lever combination, centred finally on the back or second bottom roller and also having a catch capable of driving rack wheel on back roller.

When the cam forces the levers upwards the catch and catch wheel force the back rollers momentarily forwards very much faster than the ordinary speed, but not faster than the front or delivery rollers. So far as the thick soft sliver or "effect end" is concerned this sliver is first drafted out thinly, and for the slub is drafted little or none.

The underlying principles of producing slubs by a variable back roller speed are much as in the first or mule motion, but a doubling or combination of yarns is obtained, and with a possibility of much greater effect in colour, weight, thickness, and strength of product. Size of slub altered by the levers and pitch of slub by different cams. A thread of this kind should afterwards be re-twisted with a fine thread and opposite twist on an ordinary doubler.

Loop Yarn and Snarl Yarn.

Loop yarn may be composed of two, three or four individual single or doubled threads, delivered at different speeds, and twisted together at the doubling frame, tight threads with very slack ones, in order to produce the loops.

Special devices are required to obtain the looping effect, and best results are obtained by using the fancy yarn doubler.

Two pairs of rollers may be used.

In a simple loop there may be two good ground threads, 20's to 30's ordinary twist, clockwise twisted.

These two threads, A, B, pass separately and continuously between the back pair of rollers, round a guide, E, and through the grooves 1, 2, of the front rollers. The back rollers may only have about half the speed of front rollers, and slow speeds are needed for good results.

The loop yarn, C, passes only through the front rollers at full diameter, at such an excess speed that the slack yarn loops round the base yarn, which controls the traveller. The quicker the relative speed of front rollers in relation to back the larger the loops. Only limited twist may be needed. Twist way of spindles.

After making the loop yarn, it should be doubled with a fine binding thread at an ordinary doubling frame oppositely twisted 10 or 12 turns per inch.

A thick, clockwise twisted loop yarn may be used.

Above gives continuous and frequent looping, $\frac{1}{2}$-inch or so apart Intermittent looping may be formed by adding a variable drive to the back pair of rollers, and if the loops are required to be widely apart, say 8 inches to 12 inches, special mechanism may be necessary. The same method may be employed to give a snarl yarn.

Loop Yarn.

Referring to the small Fig. 78 Ground threads = A, B. Loop yarn, C. At 1, 2, are grooves in front top roller.

The two outside threads come through a back pair of rollers (not shown) at possibly half the surface speed of the front pair of rollers from which they are shown issuing via grooves in the front top roller, so that this front pair of rollers do not control the delivery rate of these two outer threads for the ground-work.

The centre thread passes only through the grip of these two front rollers and may, for example, issue at double the rate of the other two.

The two tight ground threads twist and embody with the centre slack loop yarn, so that this centre thread develops the loops as shown.

Positions of pairs of rollers to suit the required driving and guiding of the threads.

Component threads as required in colour, counts, folds, relative speeds, material. Gearing, levers or cams for required driving.

A variant from the loop yarn method just described is illustrated in Fig. 79, but is not a very good one.

Only two threads, cops, or bobbins are used as at A, B, these being varied in counts, colour, material, twist, and folds to suit requirements.

Two pairs of rollers, F, G.

Of the two threads, C, the ground thread, is gripped by the back rollers, but is delivered freely through the grooves in front rollers at a much slower speed than the other thread or loop thread, D, which operates in the opposite fashion from C by passing freely through a back groove to be gripped, and delivered at double or more the amount of the ground thread, C.

The quicker thread, D, loops round the slower one, C, but the looping effect is not nearly so good as with two separate ground threads.

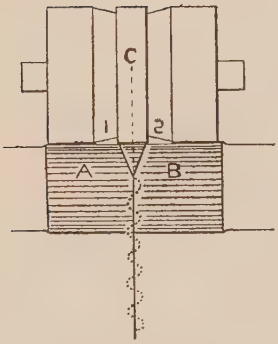

Fig. 78.

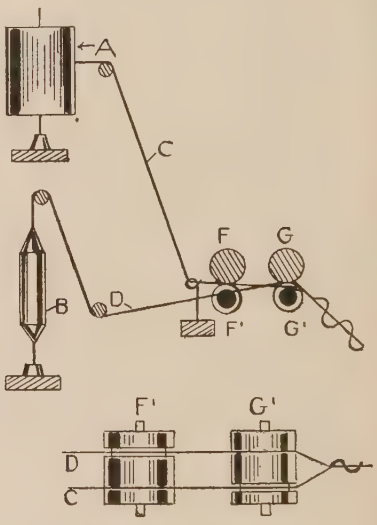

Fig. 79.

The method just described and illustrated for making loop yarn may also be employed to give a snarl yarn, with the essential difference that the central "effect" yarn should be extra hard twisted or possibly double spun up to over 60 turns per inch. Much depends on the character of the "effect" yarn since the double spun finer thread will produce "snarl yarn," while the softer and thicker yarn will produce loop yarn. In either case the special nature of the central or "effect" thread will greatly increase or diminish the result aimed at.

The looping thread may be held in centre of front top roller by a special guide or possibly by a central groove cut in the back roller.

The looping effect may be more prominently obtained by using a knop "effect" yarn.

It is possible to produce loop or snarl yarn by the vibrating bar method used for knop effects, using the correct kinds of component yarns, and keeping the "effect" and ground threads apart by a rod or wire, at the thread boards.

Also by using a front top roller which is only cut or grooved in certain portions of its periphery. The "loop" or effect yarn passes always through the central full diameter of rollers. The ground yarns are delivered at the same speed when full diameters of top roller are touching bottom roller, but these ground yarns reduce or cease delivery when the thin portions of top rollers are opposite the bottom roller. At these times the ground threads control the traveller, reduce or stop winding-on, while the "effect" loops or snarls round the ground yarns.

Knop or Knot Yarn.

Flakes may be termed soft tufts of roving regularly detached and then twisted upon or into the ground thread.

Slubs are often more definitely a portion of the thread itself, and if produced on a spinning machine there may be only one thread having thick and thin places systematically produced without using an "effect" yarn.

Slub yarn produced on doublers may combine a soft yarn or roving continuously with one or more thinner yarns, the slubs being of a longer nature than flakes and knops.

Fine knop yarn has spots of a harder nature than flakes or slubs, and usually consists of a thread instead of a roving definitely twisted round another at regulated intervals to produce the knops, the knop or effect yarn being usually distinctly thinner and better twisted than in the flakes or slubs produced at doubling frames.

Knop yarns of one description or another, produced either on modified spinning or doubling frames, or better still on fancy doubling frames, represent a very popular type of "novelty" yarn from wool or cotton, or mixtures of these.

Knop, node, spot, or knot are all terms applied to the same kind of fancy yarn.

A true knop really consists of a knot of ordinary twisted yarn knotted round the ground yarn or thread.

Mechanism for producing a typical knop yarn usually possesses the distinctive feature of a vibrating bar (sometimes two bars) for alternately slackening and tightening the knopping yarn, whereas the other classes of fancy yarn mostly do without this vibrating bar.

In the fancy doubling frame two lines of rollers are more usually employed to produce well-regulated knop effects, the knopping thread passing through one pair and round the vibrating bar, while the ground thread passes through the other or front pair and directly to the spindle or bobbin.

Knopping on Spinning Machine.

In many other examples the knopping yarn does not pass through any rollers, but directly from creel to the vibrating bar, this method simplifying the operation, but scarcely controlling the

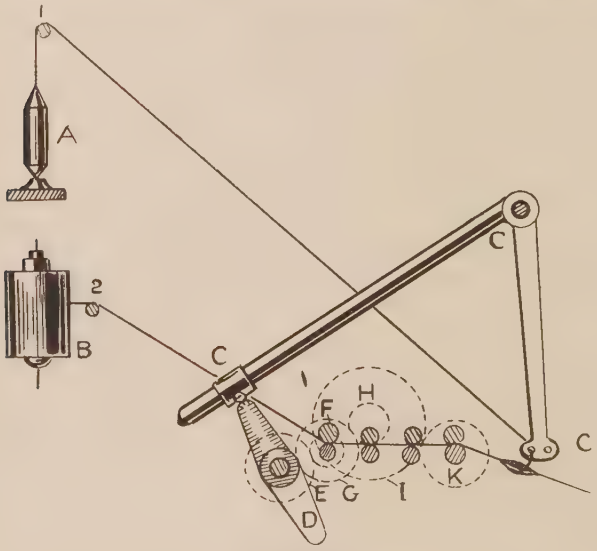

FIG. 80.

knop as the other method of having the knopping yarn pass through a pair of rollers. In any case the vital factor for knopping is a vibrating bar which alternately keeps yarn tight, and then releases the yarn more or less quickly, for the clock yarn to twist round the ground yarn.

In Fig. 80 is illustrated one method of vibrating bar knopping, with the knopping thread free from roller control. Fundamentally the ground thread could be a ready spun thread passing through only one pair of rollers, but this figure shows an application to a spinning mule or frame with four pairs of draft rollers for worsted foundation yarn. The rollers draft the ground thread from a roving,

but if for cotton only three pairs of rollers would be necessary on a mule or ring-spinning machine, while if using a doubling machine only one pair would be necessary in a case of this kind, or two pairs if the knopping yarn must be roller controlled.

In Fig. 80 the ground material passes from the bobbin, B, directly through the three or four pairs of rollers, and is drafted and twisted in the ordinary spinning manner, the usual four draft wheels being shown at K, I, H, F. The knopping thread passes directly from the cop or cops at A, straight round the faller wire carried by the bar, C, and stretching the length of the frame.

From this figure the method of forming the knops will now be readily comprehended.

Driven from the bottom back roller by wheels, G, E, is a double cam, D, which in its rotation—aided by return weights or springs—constantly vibrates the lever, C, C, C.

In this way the faller wire first raises the knopping yarn so as to tighten the same, and allow it to double and twist with the ground yarn for a short length ; then the faller wire descends more or less suddenly, and throws a length of slack knopping yarn upon the ground yarn. In this way the knops are formed by the slack yarn twisting and knotting round the ground yarn at intervals.

Sizes and intervals of the knots are affected by the speeds and shapes of cam at D.

Knopping on Fancy Doubler.

As before stated the most perfect knopping effects are produced on a fancy doubling frame, having speed pulley driving to give any desired speeds of spindles and rollers—usually on the low side—and equipped with various special mechanisms for producing desired effects.

In a typical case the knop effect requires two lines of rollers some little distance apart, not set out for roller drafting, but with the ground thread passing only through the front or delivery pair, and the knopping yarn only through the back pair, both pairs having a uniform speed. The ground threads go right from front roller to spindles, but the spotting yarn from the back roller passes over a vibrating bar or faller wire which holds this spotting yarn always above and in front of the delivery rollers. The faller bar is raised by a suitable cam, and then descends more or less suddenly, so that the surplus yarn thus produced will knop or coil round the ground thread. Distance from knop to knop, and size and shape of knop may be varied by using different wheels, cams, lever connections, and component yarns or threads.

For example, a triple cam would give three times as many

vibrations of faller wire, and three times as many spots as a single cam with smaller spots, if other mechanical details are untouched.

Cams of different shapes form part of the equipment of a fancy doubling frame.

As the faller wire rises it may help to bind in the knops, but to produce a fully completed and very durable effect, the knopped yarn is best redoubled at any ordinary doubling frame with a fine thread, or by using only the front rollers of the fancy doubler. There are cases of two vibrating bars being used in making knop yarns.

In the fixing by redoubling in opposite direction very few twists per inch are needed—in some cases only three or four.

Spiral Yarns—Corkscrewed Effects.

The ordinary corkscrew yarn is obtained by the straightforward twisting together of a thick and a thin single or doubled yarn. As required, the two component threads may be twisted either weft way or twist way, or one different from the other, and the two may be twisted together in either direction to produce the special effect desired. For example, the "effect" yarn may be a thick, soft-twisted single, and the base yarn a fine, hard-twisted two-fold.

In a good spiral or gimp yarn examined by the writer several reasonably fine and fully twisted single yarns were twisted together to form a many-ply yarn. This effect end of mercerised cotton being twisted with a strong, fine thread of greater tension, the many-ply was crimped into an exaggerated corkscrew effect, with the lines showing out very nicely and prominently like so many pearls.

A Typical Plain Corkscrew.

For a thick corkscrew example take either a good clean 6's preparation or condenser yarn, or an extra twisted roving twist way, and double these together weft way, 13 or 14 turns per inch. Use for a base end. For an effect end take a $\frac{3}{4}$ hank slubbing well twisted twist way.

Double and twist these two together weft way with half a dozen turns per inch. Ordinary doubling frame.

A still more simple example is to take 2 or 3 4-hank rovings and twist them together twist way, about 6 turns per inch, and then twist this product weft way with any ordinary single twist thread, 40's to 60's or a 2/80's.

For a fine gimp or spiral take a base end of 60's/3-fold, an effect end of 30's/5-fold, one weft way and the other twist way, the base

end having weft way twist, $\sqrt{\text{counts}}$ doubled $\times$ $3\frac{1}{2}$, effect end $\sqrt{\text{counts}}$ doubled $\times$ $4\frac{1}{2}$ twist way.

Final doubling twist way about 14 turns per inch.

At times fashions in ladies' blouses have run strongly in "voile" effects, using thin hard yarns to obtain a fine, neat, clear cloth effect, with or without pattern effects, but not needing any fancy or novelty yarns.

At other times blouse fashions have demanded the spotting effects of novelty yarns, and in skirts and dresses the demand has been more constant for yarn spot effects.

Excellent spiral or gimp effects are produced by more or less complicated blendings of several threads representing the net ret sult of four or five separate doubling efforts in the componen- threads.

To produce a simple corkscrew or spiral, a two-fold base thread may first be prepared, plain or grandrelle, on the doubling frame, or two or three separate bobbins may be used if separate colours are wanted to be twisted together in making the spiral. The base thread or threads may now pass through the ordinary rollers of the doubling frame.

The effect bobbin may be arranged separately in the creel, the end therefrom taken over a guide distinctly higher but vertically above the ordinary thread-board wire, so that this effect end may pass directly down to and through the thread wire, at which place it unites with the base end, after the latter has been partially twisted. The loose effect end will then irregularly corkscrew around the definitely controlled and tighter base end. Second twisting opposite to primary ones.

A more definitely controlled corkscrew or spiral effect than as above, may be mechanically fostered by running the "effect" yarn through an auxiliary pair of rollers before going straight from these rollers down to the thread board. These auxiliary rollers may be driven by change wheels at any speed suitable for developing the spiral effect on a regulated and definite basis.

Twist Way and Weft Way (Fig. 81).

An astonishing number of effects of one sort or another are obtained in the textile trade by the ability to twist yarn either twist way or weft way, the former being clockwise, or screwing up at the spindle when looking down on spindle top, and the weft way being anti-clockwise revolution when looking down on spindle point.

In Fig. 81 the left-hand and centre sketches illustrate twist way and weft way in both spindle and yarn.

The right-hand details, A, B, show the making of cabled sewing thread.

At 1 the twisting of single yarns twist way; at 2 twisting into two-folds also twist way; at 3 the final weft way twisting of the six-cord.

At B is an enlarged view of the twisted final appearance of six-cord sewing.

Differences in Textile Fibres.

Five possible methods available for distinguishing fibres, namely, (1) general observation, (2) microscopic examination, (3) chemical tests, (4) dyeing tests, and (5) burning tests. As regards (1)

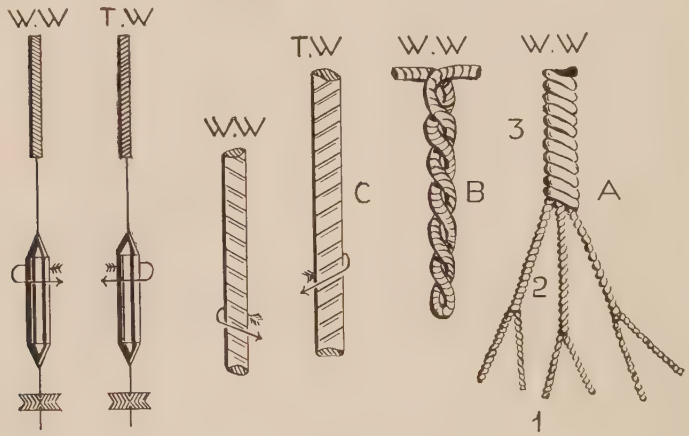

Fig. 81.

cotton fibres are short, soft, white to brown in colour, and not easily wetted; wool fibres are comparatively long, vary in colour according to class, firm and springy to the handle and greasy to the touch; flax fibre is stiff, rough, moderately long, and greenish-grey to buff in colour; while silk is somewhat wiry, very smooth, practically unlimited in length, and white to yellow in colour. As a single test (2) is probably the most reliable. Cotton appears as a twisted and collapsed tube; wool is seen to have a scaly surface; flax a straw-like surface with notches similar to those of a bamboo rod; while silk shows as a smooth glass rod. (3) Animal fibres are unaffected by acids, but are disintegrated by alkalies, while vegetable fibres are destroyed by acids and unaffected by alkalies. (4) Certain dyes and processes are available which only take effect upon certain materials, thus we have "direct"

cotton dyes which only act upon cotton. (5) Vegetable fibres burn readily on the application of a light; but animal fibres burn with difficulty, and only so long as they are kept in contact with the flame; they also give off a pungent odour, and form beads of ash. "Silk noil" is the name given to the short fibres extracted in the process of "waste" or "spun silk" spinning. "Grandrelle" is a doubled yarn composed of differently coloured threads. Gimp is a fancy doubled yarn composed of a thick, soft spun thread which is given off quickly during doubling, and bound in a wavy condition by a pair of fine threads. "Knop yarn" also is a fancy doubled yarn in which one of the threads is delivered rapidly at intervals to form knops or lumps upon the thread.

Textile Fibres.

The chief fibres used for thread-making purposes are silk, wool, cotton, flax and jute. Others of less importance are ramie or China grass, hemp, and asbestos. As regards special qualities take *first the strength.* China grass, flax, hemp, and jute may be classed as very strong. Silk and wool as strong. Cotton as moderately strong, and asbestos as weak.

Secondly, the Elasticity.—Silk and wool are very elastic, cotton is moderately so, and the remainder are inelastic.

Thirdly, the Smoothness.—Silk is exceedingly smooth, wool and cotton are moderately smooth, flax, China grass, jute, and hemp in their raw state are comparatively rough, but when cleansed of all impurities the resultant threads may be classed as smooth. Asbestos has a greasy smoothness, but its use for fabric production is considerably limited by the coarseness of the yarns.

Fourthly, the Weaving Qualities.—The combined strength of silk, wool, and cotton yarns render them comparatively easy to weave either as warp or weft, but the other fibres are more difficult to deal with, especially as warp, on account of their inelastic nature and stiffness.

Heat Retention and Conduction.—Silk and wool retain heat to a greater degree than any other fibres; cotton comes next; the bast fibres possessing little power to retain heat. This may be tested by wrapping vessels containing hot liquids in cloths of the various materials, and noting the length of time which elapses before the liquid becomes cool.

Inflammability.—The vegetable fibres are very inflammable; animal fibres only burn with difficulty; and asbestos is non-inflammable.

Retention of Weave Effects.—Usually the smooth and lustrous materials—silk, worsted, and cotton—intensify and retain weave effects better than rough or fibrous yarns such as the bast fibres

and woollen, but the style of finish given to the cloth may modify this to a considerable extent.

Flexibility.—Silk, cotton, asbestos, and most wools possess this property to a much greater extent than the bast fibres.

Durability.—In the sense of power to resist wear and tear materials made from the finest fibres possess this property to the greatest extent, because the fibres can be closer spun, and retain a better hold upon one another. From this point of view silk is the most durable, then flax, cotton, ramie, and wool. Jute is the least durable on account of the shortness of the real or ultimate fibre. When subjected to the action of moisture jute fibres are easily disintegrated. The author tested some $\frac{3}{8}$-inch jute rope for a fast machine drive and almost at once the surrounding parts were covered with short bits of the jute fibre. The rope was used up before a $\frac{3}{8}$-inch cotton rope showed any signs of wear in same position.

Paper yarns as tested by the present writer, at about 20's cotton counts, will weave as weft quite reasonably well; but in spite of proofing, remains very stiff; likely to soften with wet; is somewhat brittle.

"Pearly" Yarn.

The dictionary definition of a pearl is: "A hard, smooth, lustrous body, of a roundish, oval, or pear-shaped form." "Something as round and as clear as a drop of dew." A pearly effect in a two-fold yarn is one in which the screw-like appearance is developed as much as possible, the pearly or gimpy effect being aided by the rays of light being reflected exceedingly well from the yarn. The convolutions of a good "pearly" yarn, when examined in a really good light, appear to reflect separately, and to give out a line of bright points which produce the pearly appearance, and hence the name. At times considerable quantities of this "pearly" yarn have been wanted.

Speaking generally, "pearly" yarn may be a good quality two-fold, usable for such purposes as embroidery, and possible in blouse effects, or in any goods in which the "pearly" effect is required to stand out very prominently in the fabric. It is the custom for the doubler to use a good quality of combed single yarn, say, of 60's counts or so, very well twisted, using a twist constant of about square root of counts $\times$ $4\frac{1}{2}$. Then two of these well-twisted singles are doubled and twisted together, with the twist the reverse way from the spinning twist, using the small twist constant of about square root of counts $\times$ $2\frac{1}{2}$. This method of high twist in single yarns, followed by low twist in doubling, combined with the reverse doubling, has been found to give the maximum "pearly" effect.

Always dependent primarily upon the principles just laid down, the pearly yarn may be used quite plain, or it may be gassed, mercerised, or coloured, according to any particular requirements. It is quite evident that these subsequent operations will afford considerable scope in the produced goods, ranging from moderately priced goods, up to quite expensive ones.

The drag or tension placed upon the yarn in the doubling frame should be kept as mild as possible, consistently with maintaining accuracy in the counts, and in the winding of the yarn. The stop-motion doubling winder may be used for winding the two single yarns together prior to using the twisting machine or doubler proper.

The writer examined a much thicker and very pronounced example of pearly or gimp yarn having five or six single yarns of about 20's to 30's mercerised yarn twisted together in one operation, and then twisted the opposite way in a redoubling with a good, fine two-cord binding thread, which developed the pearly effect strongly.

Knicker or Nepped Yarns.

Ordinarily, in cotton spinning, nep is a nuisance, and every effort is made to prevent or eliminate it, such as by maintaining sharp wire, good settings, parts in good condition, and satisfactory stripping at the card, or even by using the comber.

Sometimes, however, there is a market for yarn in which nep has been definitely introduced.

First of all the nep is made by special treatment at the *roller and clearer card*. For this purpose a plain blank casing may be used beneath the taker-in.

A number of the usual parts of the card need not be used, such as the doffer and coiler, and the cylinder under casings. Ordinary scutcher laps may be fed to this semi-card.

The prolonged treatment by the rollers, clearers, and cylinder roll up the fibres of cotton into small bunches or neps, which are thrown off the cylinder by centrifugal force, and into a trough or box beneath the cylinder.

Ordinary working speeds for cylinder, rollers, and clearers, very coarse, so-called needle pointed wire for cylinder and doffer. No fancy roller used.

After the neps are made, the nepped cotton is treated by an ordinary roller and clearer card, fitted with a closely woven apron feed which will not permit the neps to fall out. For the same purpose blank under casings are used beneath the licker-in and cylinder. Ordinary scutcher laps may be fed along with the required proportions of nep, possibly half and half.

At the draw-frame, nepped slivers and ordinary slivers are mixed and proportioned as required, $\frac{1}{6}$, $\frac{1}{3}$ or $\frac{1}{2}$ nepped.

An ordinary ring-frame is mostly used for the spinning, the yarn counts ranging 15's to 30's. The neps are too short to be extracted or drafted by rollers. This method of producing fancy yarn effects differs radically from those obtained at spinning and doubling frames.

CHAPTER XV.

MISCELLANEOUS.

Warping.

Some Bolton quilt manufacturers have now discarded the old-fashioned ball warping process entirely in favour of a method introduced from Yorkshire and briefly explained below as examined by the writer in a Bolton weaving mill.

The warpers' bobbins of strong yarn—often doubled—are placed in creel which can be easily pulled on slip-ways across the face of a horizontal mill or large reel of about 6 feet diameter, and possibly 3 yards wide.

A substantial headstock of gearing is fixed at one end of the reel or mill, the gearing being divided into two halves, one of which gives frictional rotation to the large reel when the yarn is being drawn from the bobbins upon the reel. A very high speed of the yarn is obtained when good doubled material is being used, and the speed requires proportioning to prevent over-running of bobbins and giving slack yarn.

A narrow reed—possibly about a foot wide—assembles the warp threads, and a start is made by winding this width of yarn near one end. When sufficient length has been wound on, the reed is moved to bring the next section over the end of the first, and so on until the full width of beam is obtained and of required number and length of warp yarn. Some firms try to use the same reed counts as required on the loom. This operation finished, the feed or creel end of machine is disengaged and the delivery end put into gear. By this means the warp threads are now transferred in a proper manner from the huge horizontal reel, to the wide weaver's beam. This method is not only cheaper than making ball warps, but gives straighter warp threads and enables quilt weavers to earn more wages.

Scotch Warping Mill.

In the Yorkshire wool and worsted districts the term "Scotch warping mill" is sometimes applied to the large horizontal warping reel above described as coming into use for cotton. In the Scotch warping mill the warp is wound after the form of sections.

There is a movable creel, a guide, lease-taking and tensioning apparatus.

The creel is often arranged in a compound or double manner so that one half may be filled as the other empties. Each half may contain from 200 to 300 cheeses or else flanged warper's bobbins. It is possible to build up a warp in about 16 sections of 4 inches width or 64 in total width. As before described the stand for the weaver's beam is placed on the opposite side from the creel. When the gearing is reversed to stop the creel and run the weaver's beam, there is usually a very stout brake to prevent over-running of the large reel or mill.

It is possible to make beams in which it is difficult to see any joining of sections. An even thread tension is obtained, the threads are kept very straight—much better than in ball-warping—and nice, level weaver's beams are obtained. To avoid waste it is good practice to have the warper's creel bobbins or cheeses, each containing the same equal length of yarn.

After each section has been made, the yarn guide is carefully moved laterally, the threads cut, and then rehooked in the new position for the next section. Each section is started with an end-and-end lease.

In ball warping some workers prefer to start the warp at the top of the mill and others at the bottom.

Winding Notes.

1. Cross winding with quick traverse for fine yarns of 100's to 120's appears to knock the yarn about more than some people care about.

2. To get firm cones on cross winders some people set hard on nose by putting a paper thickness between empty cone spool and drum.

3. In end unwinding from quick traverse cheeses it is well to remember in the unwinding that any running off at the ends will be done best with the bad end at bottom.

Ratio of Traverse Rate to Winding Rate.

In some quick traverse winders it is the custom to operate the traverse at a fixed speed, and to increase or diminish the drum speed by a single change wheel according to the different kinds of yarn.

It is well understood that doubled yarn requires a higher ratio of traverse than an ordinary single yarn. This ability to alter the drum speed—and therefore to readjust the winding on rate to the traverse rate—facilitates the production of well-built cheeses of yarn for any description of yarn.

Some drum winding frames are arranged to enable each side to be altered independently, and this is a good thing when different kinds of yarn are to be wound.

Pirn Winding.

The original and fundamental idea of pirn winding is to re-wind into cop shape yarns that have been bleached, dyed or otherwise treated in hank form, in some cases after yarn has been reeled and bundled for export and transport purposes. Cone cup winding has for a very long time been extensively used for pirning.

A more recent idea is to re-wind even grey yarn upon special winding frames such as the No. 90 Leesona, or the Schweiter Rapid weft winder.

Although winding adds distinctly to the wages bill, yet there are possible advantages to both spinner and weaver. The spinner may spin cops of good length and diameter—say $7\frac{1}{2}$ inches × $1\frac{1}{4}$ inches instead of possibly $4\frac{3}{4}$ inches × $\frac{7}{8}$ inches.

These being re-wound on the "Leesona" or other pirn winder assume such a hard, compact form that each cop lasts distinctly longer at the loom.

It follows that both spinner and weaver benefit in having less labour and fewer stoppages in making or using larger cops respectively. One re-wound weft cop = 2 to 4 mule weft cops.

The crossing coils on the cop nose produced by short front loose incline of the mule copping rail, alternating with the closer wound coils due to long incline of mule copping rail, are not conducive to the nice appearance of the cloth nor to nice unwinding at the loom.

The No. 90 Leeson pirn winder is a typical illustration of the modern system of pirning to offer advantages suggested above.

This machine contains the central idea of a double row of horizontal spindles, driven separately by a series of helically geared wheels fixed on a shaft extending lengthwise of the frame and rotated by fast and loose pulleys, so that the drive is almost noiseless. A dust-proof gear box is used for each pair of spindle wheels, and the casing forms an efficient self-contained and automatically distributing oil-box.

Within the box is a rocking shaft controlled in a different gear-box at the head of the frame and obtaining its motion from a horizontal cam. The cam obtains its motion from the main or spindle shaft through gears which give a fixed traverse to the yarn to be wound.

The cam gives the required relation between the "wind-on" and the traverse of the yarn.

Different conditions have been specified as below :—

3-wind for tyre fabrics—or 3 coils of yarn for one traverse. 3-wind also for other heavy yarns.

5-wind and 7-wind for most average kinds of yarns.

10-wind for the finer cotton yarns and for silk, up to 14-18-wind for very high winding speeds for fine silk.

The correct relations between "wind" and "traverse" are obtained by changing the ratios of the gearing wheels driving from the chief spindle shaft to the cam. The rocking shaft helps in giving a quick reverse at the traverse "ends" and plays a good part in giving good cop noses.

The traverse for use with cops varies with the kind and counts of yarn, but is somewhere about equal to the length of the heel. The traverse may go through the range of 1 inch, 1·18 inch, 1·35 inch, 1·52 inch, 1·67 inch and 2 inches.

A small disc is threaded on a finely threaded screw which forms the traverse bar parallel to the spindle. At the end of each inward traverse the disc makes fine contact with the full diameter of revolving pirn so that a slight rotation is given to the disc and to gradually move the disc and the yarn guidance nearer to the spindle tip and giving a corresponding effect to the shaper screw of a mule or ring-frame. The spindles have constant revolution, and a very sensitive yarn tension is used.

The fork thread-guide slides on the traverse bar and goes with the disc laterally, while the disc has also power of rotation. The use of a bobbin with a thick base will give speedy contact and lateral traverse to the disc. A small shaper plate is used when thin paper tubes are used.

A good deal of winding upon pirns is done in the case of silk from reels or swifts, and careful tensioning and running are necessary to avoid entanglement and breakage of the expensive yarn.

Means are provided to obtain a maximum speed of swift or reel without creating the danger of over-running. At the same time attention is given to starting up each reel or swift without undue tension and pull going upon the yarn. Brake and compensator attachments attend to these features.

When the spindle starts the silk is drawn through a compensating device and the brake is released; a very slight pull starts the reel.

Breakage of the silk thread releases the compensator and applies the break instantaneously. At most 1700 r.p.m. of spindle winding may be done for really fine cotton or silk.

A varying winding speed rate is obtained in winding alternately on the base and apex of the pirn, with differing diameters between, but the sensitive tension helps in this.

In this tension the yarn is passed between a pair of metal

discs whose faces are kept together by a weighted lever, the discs having an intermittent rotary movement transmitted from the traverse bar.

To suit winding of Northrop loom feeler bobbins a bunch builder ring frame attachment may be added in order to wind a bunch or reserve portion of yarn as required for the feeler motion for changing from empty to full spool, or for transferring purposes.

A special heavy type of unrolling attachment and compensating device is made in the case of heavy materials such as tyre yarns from twister spools to shuttle pirns.

Quickly acting brakes are fitted and adjustable counterweights are fitted to the spindles in which the bobbins rotate. In such ways there is obained a wide range of tension to suit different materials.

For winding "bump" and other thick soft weft yarns for quiltings and other goods, the old vertical cop pirn winder maintains a great deal of favour.

Camless Winding Frame.

Yarn traverse motions and cams or other means for working the traverse motion have attracted an enormous amount of attention on the part of makers, users, and inventors. Large cams operate full lines of guides in some cases; in other cases one cam to one spindle or spool, split drum cams, and other forms represent almost endless variety.

For some years Messrs. Hetherington have made quick traverse winding frames without any traverse rail, split drum, eccentric, or cam for traversing the yarn along the face of the cheese or spool.

The aim has been to traverse the yarn without using any reciprocating mechanical feature, and to use a traverse motion which is smooth, silent, and circular.

The yarn is moved backwards and forwards along the spool face by means of two projecting fingers revolving continuously in one direction, and driving two similar-shaped fingers in the opposite direction, a perfect timing action being obtained. Each thread or spool has its own pair of double yarn crossing fingers.

One finger carries the yarn across a fixed guide rail, and, reaching the end of the traverse, the yarn slides over the disappearing finger rounded end, to be instantly caught by an oppositely revolving finger which sweeps the yarn again to the opposite end of the spool. This action is repeated by the other pair of fingers, so that two double yarn traverses are obtained from the four fingers, each finger representing one single traverse.

An extremely high traversing and winding speed is obtainable

from this kind of traverse, and it is good for coarse yarns or adaptable to very fine two folds of cotton, wool, worsted, or mohair.

Either soft wound or hard wound cheeses are feasible, and cones may easily be produced.

Stop-Motion (Fig. 82).

Referring to Messrs. Arundel's machine with patent stop-motion, as shown in Fig. 82, which can be made for winding any number of ends up to 24 on to paper or wooden tubes. All gears machine cut. Speed only limited by the character of the yarn. Standard size of cradle made for tubes 6 inches × 332 bore. Frame gauges can be made 8-inch gauge for 6-inch cheese and 10-inch gauge for 8-inch cheese.

Special pattern cradle for building conical cheeses of any desired taper, and capable of being very quickly altered to make parallel cheeses of yarn.

In Fig. 82 is shown a sectional view of frame and specially illustrating the stop motion.

The simplest form of drum winder is made without stop-motion and for winding one end only per drum.

The stop-motion for the doubler winder is of the detector box type, but has been subjected to great study and practical tests, resulting in detailed improvements which give great rigidity and quickness of action. High doublings at two operations.

The brake is set very close to the empty tube, and as the tube fills, the brake automatically recedes, leaving just the same clearance at every diameter of cheese.

This feature permits the brake to be set extremely near to its work—more so than with a fixed brake, which is set far enough away to clear the largest diameter of cheese.

Another special feature is that when an end breaks and the cheese drops, the brake simultaneously rises to meet the cheese. It will be realised that the combined effect of the close setting of the brake, and double action of brake and cheese, will give a particularly prompt stoppage of winding, and make it scarcely possible for the loose ends of yarn to get on the cheeses, even at very high winding speeds.

Stop-motion needles or detector wires may be changed to different weights or counts without taking the box out of the framing, an advantage that shows up greatest when using different sorts of yarn.

It is stated that one girl will mind 20 to 30 spindles on the quick traverse stop-motion winder, varying with counts of yarn and number of ends per cheese. Two horse-power per 120 drums. Width, 3 feet8 inches over all.

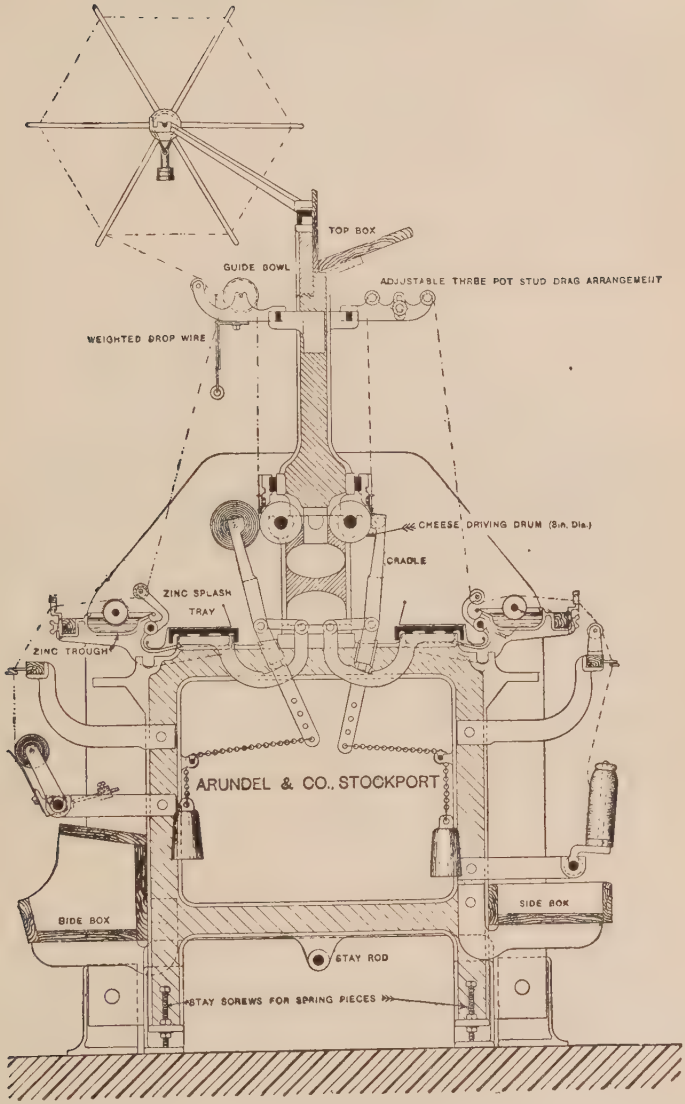
TOP BOX
GUIDE BOWL
ADJUSTABLE THREE POT STUD DRAG ARRANGEMENT
WEIGHTED DROP WIRE
CHEESE DRIVING DRUM (8-in. Dia.)
CRADLE
ZINC SPLASH TRAY
ZINC TROUGH
ARUNDEL & CO., STOCKPORT
SIDE BOX
SIDE BOX
STAY ROD
STAY SCREWS FOR SPRING PIECES

FIG. 82.

Arundel's Quick Traverse Winder for Single Ends (*see Fig.* 83).

The illustration shows the frame without stop motion arranged to wind as below stated :—

1. Bobbins endways, with pot stud drag shown on right-hand side of machine.

2. Double flanged bobbins, sideways, carried by patent presser

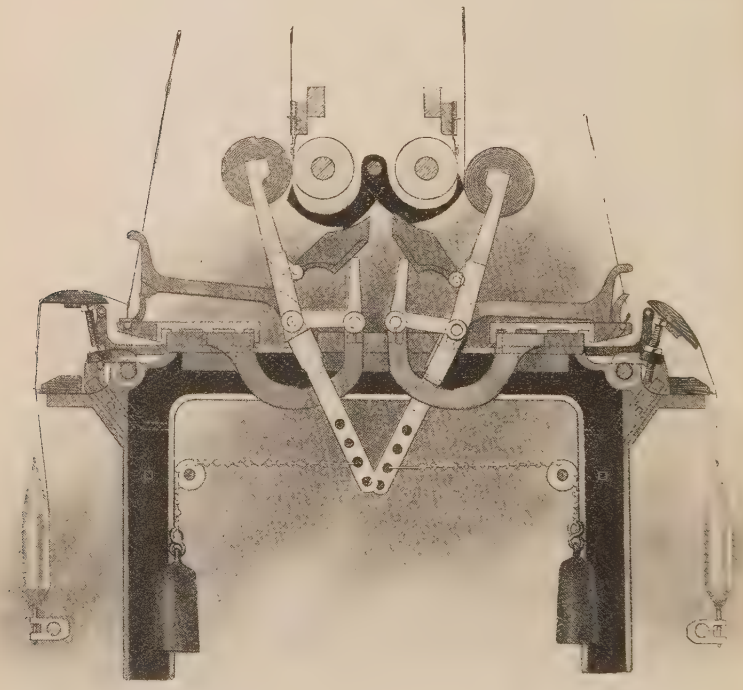

Fig. 83.

re-winder to prevent bobbins over-running. Left-hand side of the machine. If required, these bobbins may be wound from rabbeth spindles in cast iron rail.

3. The machine can be arranged to wind from 54 inch or 72 inch swifts, carried by brackets above the frame, and if required, may be fitted with patent drop tension wire to take up slack yarn. Shown on left-hand side of machine.

When required, the machine can be fitted with damping or conditioning arrangement consisting of brass roller running in copper trough with special zinc splash tray to protect the beam and collect waste liquid, and arrangement to the traverse yarn to prevent cutting of brass roller.

The damping roller is usually driven by rope pulleys, and, if desired, can be arranged with change wheels.

These machines work most satisfactorily in flax, worsted, cotton and silk yarns, and with the method of changing speeds and ratios give excellent cheeses of any size on any class of yarn.

There can be supplied when desired the new patent variable traverse arrangement which enables the traverse to be varied by degrees from 5 inch, 4 inch, and to $2\frac{1}{2}$ inch or from 6 inch, 5 inch, and to $3\frac{1}{2}$ inch without changing the cam.

Care of Quick Traverse Winders.

Messrs. Arundel give the following points:—

1. Cam box must be partly filled with a mixture of oil and grease or with thick cylinder oil. This oil must be renewed occasionally, the plug in bottom of cam box being provided for removal of old oil.

2. Note periodically that the change wheel and carrier bracket nuts are tight.

3. To minimise wear of cam boss ends, gun metal thrust collars are provided; any possible wear, however, may be taken up by loosening the cam shaft locking set screw and adjusting the nuts on the cam shaft end.

4. Oil the drum, driving and detector shaft bearings once or twice per day.

5. Oil the top runner bowl pivots periodically, using as small a quantity of oil as possible.

6. Oil the cradle spindle ends after each cheese is wound.

Note.—A small felt pad soaked in oil is very useful for the two last named operations.

7. Oil the traverse wires against each carrier bracket.

8. The off end gear wheels should be covered with tallow or grease.

9. Clean out the detector boxes, traverse wire carrier brackets, and top runner bowl brackets periodically, as fluff is liable to prevent the above parts from working satisfactorily.

10. Note periodically that the cop skewers point exactly to the yarn guides.

11. Note that the hand lever, when in working position, will not lift more than $\frac{1}{8}$ inch off the detector box finger.

12. When changing from certain counts of yarn to much

finer or coarser counts of yarn, it is advisable to change the detector wires and possibly the porcelain end guides.

13. When a number of cradles on a machine are out of use they must be drawn away from the drum, as, when in the "forward" position without a spindle, they rest against the drum shaft, and would very soon wear a groove in same.

Details of Quick Traverse Winders.

There is a choice of pot drag, rod drag, ball drag, roller drag, disc drag, pot stud drag or flannel drag.

160 drums of 5-inch traverse is a full length frame.

A much used gauge is 7-inch, especially for winding 1 to 6 ends together for the twister.

For coarse counts, or for the hosiery trade, or for assembling up to a dozen ends together, 8 or 10-inch gauge may be used.

The traverse distance is more usually 2 inches less than the gauge—say 5-in. traverse for 7-inch gauges. It is more usual to make detector boxes for 6 ends.

On quick traverse winders it is almost always better to wind off endways, with suitable cop holders or cop jiggers, for cops, and which jiggers may be fitted with metal projections for ring bobbins, or else split wood bushes may be used. Conditioning rollers are not advisable on doubler winders since the moisture tends to rust the detector wires. Yarn may be unwound endways from ring doubler bobbins, each of which is carried by a steel peg made to fit the cop jigger—special creel arrangements for winding sideways from double flanged bobbins.

If a winding frame is required to unwind sometimes from cops or bobbins and on other occasions from hanks, the swifts are best placed overhead.

Special adjustable cradles are applied when either cones or parallel cheeses may be required.

The yarn may be wound upon conical wood spools which fit in the same tube spindle as used for parallel tube.

Conical winding on paper tubes is sometimes done by placing the paper tubes upon special conical mandrils.

For cheese winding for home use the wood tubes of fair diameter are preferable to the paper tube of small diameter, since the latter permits a larger change wheel to be used, resulting in a closer wind, greater winding speed and more yarn upon same spool diameter.

Cotton Spinning and Doubling.

Syllabus, Third Year Course, 1923.

The doubling and twisting of cotton yarns. Elementary description of the various types of machines used, viz., the twiner,

ring twister, flyer twister. All details of these machines such as arrangement of creels, troughs, rollers, building motions.

The winding of cotton yarns for the creel of the twisting frame. Elementary description of the machines used, viz., slow traverse double winder, quick traverse double winder. All details relating to these machines such as stop motions, traverse motions. Arrangement of creel. Various types of drag.

The reeling of single and double cotton yarns of any kind such as soft twist, ordinary twist, extra hard twist, as put up in cops, cones, cheeses, ring bobbins or other form. Open-reeling, cross-reeling, grant-reeling or other form; reel dimensions for different markets such as French reeling, transit purposes, or dyeing; doffing or other detailed mechanisms; tying up of reeled hanks.

Bundling of Cotton Yarns.—Operations of making long and short bundles; full constructional details and working of bundling press.

Horse-power for all machines in cotton spinning and doubling mills up to and including reeling, bundling, winding and warping machinery, with varying powers required for a spinning mule or other machine.

Systems and machinery for single end cotton winding such as vertical spindle, horizontal spindle, split drum, and ordinary drum winding. Pirn winding and modern machines for winding yarn into cop form. All details of these machines such as cam or mangle wheel traverse motions, bottle bobbin motion, other traverse motions, creel arrangements (not doubling, winding).

Various methods of warping and machines therefor, with all details and accessories; beam warping, mill warping, sectional warping, chain warping, cross balling.

All calculations on any machines and processes in spinning and doubling mills and including reeling, bundling, winding and warping, but neither costs of production nor mill planning calculations.

The Gassing of Cotton Yarns.—Elementary description of the machines used, viz., slow traverse frame, quick traverse frame. All details relating to traverse motion, burners, creel arrangement.

Conditioning, packing and transport of cotton yarns; uses to which single cotton yarns are put.

Included in the course there are also the subjects of drawing, textile mechanics and textile mathematics.

Tension, Balance and Twist in Doubling.

Late in 1922 a series of investigations at the Bolton Technical School, among other results, demonstrated very clearly that tension exercises a great effect in regard to balance of doubled thread.

For example some 20's ring yarn was made into cabled six

Trials on Effect of Twist in Cabled Yarns, Especially Referring to the Twist at the 2nd Doubling Required to Balance the Twists already put in (H. Fullard, December, 1922, at Bolton Technical School).

1*st Trial.*—Single yarn 20's with 14 turns, twist way ; 1st doubling 2 ends up and 12·7 turns put in ; at the 2nd doubling 3 ends put up.

	Single Twist.	1st Doubling Twist.	2nd Doubling Twist.	Condition as to Balance.	
				Unstretched.	After Stretching.
(*a*)	14 turns 13·13 constant	12·7 turns 4·00 constant	5·0 turns 2·75 constant	Much undertwisted	Very much undertwisted
(*b*)	—	—	7·5 ,, 4·12 ,,	Slightly undertwisted	Much undertwisted
(*c*)	—	—	9·0 ,, 4·94 ,,	Balanced	,, ,,
(*d*)	—	—	9·3 ,, 5·10 ,,	,,	,, ,,
(*e*)	—	—	9·3 ,, 5·10 ,,	Balanced or slightly overtwisted.	Much undertwisted
(*f*)	—	—	9·8 ,, 5·38 ,,		
(*g*)	—	—	10·7 ,, 5·88 ,,	Decidedly overtwisted	Undertwisted
(*h*)	—	—	11·5 ,, 6·30 ,,	,, ,,	Balanced
(*i*)	—	—	12·1 ,, 6·65 ,,	,, ,,	Very slightly overtwisted
(*j*)	—	—	12·7 ,, 7·0 ,,	,, ,	Slightly overtwisted
(*k*)	—	—	13·0 ,, 7·14 ,,	,, ,,	,, ,,
(*l*)	—	—	14·5 ,, 7·96 ,,	Very much overtwisted	Overtwisted

cord by making 2-cords, and then twisting three of these together. There was about 15 per cent. above what is considered standard twist in the final doubling. Dry-doubled (1) twist way; (2) twist way; (3) weft way.

When the loop of the thread was allowed to hang down, the final thread tended to add twist. After a moderate pull by hand, there was a definite balance and "set" of the thread.

By applying still more tension by hand, the suspended thread tended to untwist or take twist out.

The weight of traveller and the application of tension in any way exercises a distinct effect on the question of producing a balanced thread.

By giving about 15 per cent. extra twist in the final doubling, allowance is made for slippage of spindle bands or other loss of twist, and yet a proper "set" and balance is obtained.

In endeavouring to obtain harder bobbins by using heavier travellers it is possible to have some loss of twist, especially if the increased tension causes a slip of spindle bands. Potential twists due to coils of yarn upon cops may develop into full twists by pulling the yarn over the cop or bobbin nose at the next machine.

Winding Notes.

(*a*) The growing use of so-called artificial silk from materials differing so widely as wood pulp by one process, and cotton linters by a different process, has led to special adaptations of winding frames to suit such materials.

By an adaptation of the long vertical spindle method as used on a pirn cup winder—but dispensing with the cup—Mr. Holt has made it possible to wind bobbins of large diameter and good length suitable for artificial silk. At present it is possible to sell artificial silk yarn at 10s. 6d. per lb. from 7d. linter cotton.

(*b*) Slip in the ordinary warpers bobbins of an ordinary vertical spindle warp-winder has often prevented thread-breakage. The non-positive drive of such a bobbin by resting upon a braid or plate of the spindle is rather good for limiting thread-breakages and militates slightly against the adverse nature of increasing winding speed due to increased bobbin diameter.

(*c*) Both cup winding and vertical spindle winding are very old, while split drum winding is anything but a new idea. It is a mechanically erratic principle to wind cones of yarn by pressing against a parallel drum. It is a question which part of the cone bites most against the drum and rules the surface speed of the yarn.

(*d*) By using pulleys or flanges of 2 inches diameter on the spindles or wood tubes of 1 inch diameter when operating a drum winder,

the initial revolutions of the cheese or spool are kept lower, so that the pitch of the spirals due to end cams is kept shorter at the beginning and there is less difference in pitch of yarn spirals as between full and empty spools. 4-yarn crossings for a full bobbin rule increase the diameter much the same as if there were a dozen coils in the cheese width, and hence the tendency to build up softer when the spirals of yarn have a wider pitch.

Let this point be well understood. Assume a cheese of yarn 6 inches wide and $4\frac{1}{2}$ inches diameter to have 4 coils of yarn in one full width traverse, and compare this with another similar cheese which contains 8 coils or rounds of yarn in the 6 inches width, due to the traverse speed being relatively so much slower in relation to the diameter and revolutions, or winding-on speed. The 4 coils cheese gets one yarn diameter increase per 4 rounds of yarn, while the other only gets one yarn diameter increase for 8 rounds of yarn, or practically twice this amount. From this feature it is deducible that a quick traverse drum winder will build a softer spool or cheese, and containing a less length of yarn, than one with a slower traverse rate, other particulars being the same.

(*e*) Drum winding frames have been devised, in which the drums are frictionally driven, on the principle of the friction driving pulley moving further from the spindle centre as the spool or cheese increases in diameter. In this way a high number of revolutions may be given to the spool or cheese of small diameter, and the revolutions of spool are reduced as its diameter increases.

This idea permits of a good uniform winding rate of speed for all sizes of spool, and does away with that notorious defect of ordinary spindle winding, viz., winding speed rate increasing with diameter. Also with equally notorious defect of drum winding, in having the pitch or distance of yarn coils increasing as the cheese diameter increases.

(*f*) More so in the soft twisted hosiery trade than for harder twistings, due regard must be had to unwinding twists. It is possible for yarn to be spun or doubled either twist way or weft way, and in the next process with the yarn coming over the cop or bobbin nose, regard should be had as to whether we want the unwinding twist to help or to reverse the previous twist.

(*g*) In stop-motion precision winders small expanding pulleys may be used to slightly compensate in yarn coil-pitch, for the effect of the yarn diameter upon the tape laying on of the yarn.

(*k*) In determining the ratio of traverse to the diameter and speed of spool and cheese in a winding frame with quick traverse, we must avoid the danger of having the yarn bunching or "lacing" at certain cheese diameters. Such bunching may cause "webbing" at the cheese ends.

(*l*) In regard to the somewhat extensive adoption of ball drag

it has been argued that porcelain cups for the balls are difficult to bake, mould, and shape, exactly alike in shape and degree of hardness.

(*m*) In a recent drag motion of the small revolving washer principle, the lower washer has been compounded with the spindle to form a kind of revolving peg-top. Upper weights are placed higher up the spindle to give the drag required.

The yarn is practically through into a wide open Vee slot and then over 2 wire guides having the revolving washer weights between. Limited wear and tear, automatic discharge of fluff and dirt, easy regulation of tension and drag, durability of parts, easy yarn threading, are among possible advantages. First cost may be rather high, but is soon compensated for by good results. The revolving peg-top reduces the chances of wear.

(*n*) It has been asserted that a horizontal spindle winder is somewhat disadvantaged in getting high spindle speeds, because it is only held at one end, and has to fight against the law of gravity as compared with a vertical spindle.

(*o*) Wire clips have been used to restrict speeds of hard twisted voiles, venetian or crape yarns to prevent snarls in the yarns.

Climax Twister and Winder.

The machine has somewhat recently been brought to the notice of the textile trade. It possesses the feature of "up-twisting," or twisting at the feed part of the machine as distinct from the better known and more used method of twisting at the producing spindle.

In this machine an old principle is re-established on an improved basis.

The following notes on this machine represent the claims of the makers, and are subject to differences of opinion amongst people accustomed to the use of doubling winding frames and twisting machines.

The desired number of ends having previously been wound on to a bobbin, cheese or cone, the package is placed on a spindle driven by a band from a tin roller. The yarn is drawn upwards over the end of the revolving spindle, and upwards over a pivoted drum and downwards on to a bobbin or cheese at a controlled rate of travel, leaving the frame ready for warper's creel or commercial use. The said "bobbin" or cheese "tube" is held in contact with a parallel drum in such manner that no slippage occurs.

Use.—For the twisting or doubling of any classes of yarn of two or more ends with any predetermined number of turns per inch twist, and the winding of the resultant twisted yarn in cheese form on to tubes or double-flanged bobbins in one operation.

The classes of yarn that can be worked on this machine include

cotton, wool and worsted, flax, net silk, spun silk, artificial silk, jute, ramie, etc.

This machine can also be used for putting extra twist into single yarns.

Advantages.—I. The twisting or doubling and winding on to tubes or bobbins is performed in one operation, thereby eliminating one process in the usual routine of first twisting or doubling on a twisting frame and then winding on a cheese winder.

Consequent on the above, economies are effected in labour, power consumption, floor space, bobbins and general upkeep required.

II. A large production is obtained as, owing to the fact that no travellers or flyers are used, only atmospheric pressure has to be overcome. The result is that much higher twisting speeds can be attained than on an ordinary twisting frame without detriment to the yarn.

III. The operation of mending and darning is eliminated, as no "single" can occur. The possibility of such an imperfection as a twisted yarn containing fewer than the requisite number of ends is entirely obviated, as the drawing-off of the yarn from the twisting spindle can only continue as long as the requisite number of ends is being fed.

IV. No stoppage for doffing. As each spindle can be individually doffed and replenished, the stoppage of the whole machine for doffing is unnecessary.

V. Perfectly cylindrical cheese and regular twist. This is due to the fact that the pressure on the cheese-carriage automatically adjusts itself to the varying diameter of the cheese, so that all lifting or jerking of the carriage is avoided.

There are no travellers, flyers, or loose rollers.

No ballooning or lashing.

No grease-marked yarn.

Method of Working,—The number of ends to be twisted is first wound in conical form and then placed upon the twisting spindle of the machine. The cone is then revolved in the same direction that it has been wound, and the yarn is drawn upwards over a bowl, and thence downwards through a thread guide mounted on a reciprocating rod, which in turn delivers the yarn on to a spool, tube or bobbin, which is revolved at an even surface speed by being held in contact with a revolving drum.

Construction.—The spool, tube or bobbin-carriage is provided with an automatic compensating pressure device, in such fashion that the pressure is gradually reduced as the cheese is built up.

Each side of the machine has separate change wheels for varying the twist.

A swinging tension motion is applied to the tapes driving spindles, ensuring equal twists on adjacent spindles.

Spindle driving cylinder runs on ball bearings.

Self-contained twisting spindles with knee brakes.

Machine-cut gearing throughout.

Size, Space, Pulleys and Power.—The standard machine has 120 spindles, 60 per side, 6½-inch gauge, making cheeses 5-inch traverse, the floor space occupied being 35 feet 9 inches × 3 feet. Machines, however, can be built with any number of spools required.

The standard 120 spindle machine has driving pulleys 14-inch diameter × 3¾-inch .ace, and the horse-power required is approximately 3.

The speed varies according to the class of yarn.

This machine attracted considerable attention at the Manchester textile exhibition, October, 1922.

This is a machine for the twisting or doubling of any class of yarn of two or more ends which have preferably been previously wound together on a stop motion winding frame.

It is also suitable for putting extra twist into either single or doubled yarns.

Its chief distinctive feature consists in rotating the spindles of the creel bobbins or bobbins of yarn fed to the machine instead of twisting at the final producing spindle of the machine.

All sorts of problems—for better or worse—are introduced in considering whether the "climax" method is fundamentally or practically better or worse than the well-established method of twisting on an ordinary ring or flyer doubler.

It is not professed that this machine is very suitable for wet doubling, although experiments have been made with damping at the top, near the small tin carrier bowl, and it was not found that the drums were rusted. It may be used for truffle or sponge cloth yarn, as for instance the following example:—

Two ends of 30's with one end of 18's put together, 23 turns, 23 inches wrapped round in 10 inches. Two processes. One end of 30's put in reverse at 9 turns. Final result a 5's truffle yarn.

Features that appear to the author as worthy of investigation are such as the following:—

1. With the variable pitch of yarn crossings often found on drum-wound cheeses, will the yarn always come end off the twisting creel cheese in a uniform manner?

It must be clearly understood the cross-wound cheeses of yarn are placed vertically on spindles driven from a central tin roller, preferably tape driving, with one tape driving two spindles on either side of the machine.

These creel bobbins or cheeses are driven from the tin roller at the speed required to give the correct turns per inch.

This method has been described as uptwisting since the yarn

is drawn upwards from the twisting spindle over a tin top carrier bowl so as to get a good length of yarn, and then down to the drum winding cheese.

Assume a spindle band to come off, there is the question of yarn winding off the creel cheese and not being twisted ; the jockey pulley of the tape drive keeps a proper tension of the tape and well-stitched tapes of good material may last several months. A good length of yarn from the feeding bobbin to the produced one allows equalising of twist and facility for piecing up.

3. Differential driving of pre-wound cheeses and greater uniformity in the crossings may help this winding twister.

4. Stoppage of a produced spool of twisted yarn from being full or any other cause should not allow twisting to continue all the time.

Good speeds are obtainable on the spindles containing the creel spools or cheeses, but a factor that may need attention is the greater surface speed and greater centrifugal force of the full creel spool as compared with the almost finished spool.

The resistance of the air is deemed to exercise a beneficial drag effect, and the ballooning of the yarn diminishes from the full diameter of spool all the way up to the tin carrier.

5. The spools or cross-wound cheeses produced on this machine are very well weighted, and need to be in order to prevent any slip of the spool on the friction driving drum.

It is no new thing to have slip in drum winding, and this affects the pitch of the crossings.

In the climax machine it is even more important to avoid slip of spool, as this would diminish the winding-on speed and presumably give over-twisted yarn.

The weighting of the spool carriage is obtained on a well-considered basis, and the amount of weight is considerable.

Breakage of an end is accompanied by the loose end winding on the bobbin.

The twist per inch may be varied by the end twist wheels all the way from one to forty turns per inch.

The twist wheels and other gearing drive the friction or cheese drums from the tin roller.

For reverse twist and reverse direction of winding on the creel cheese this latter may be turned upside down on the spindle.

The gauge of the spool produced from the machine rules the pitch of the twisting spindles.

The machine will operate on mohair yarn containing great stretch or elasticity as compared with cotton yarn.

Regular twisted yarn may be obtained. Full twisting speeds are obtainable as on ordinary doublers.

For cabling purposes the twisting spindle may be filled on the flyer principle and the yarn side unwound.

Ten inches diameter of tin rollers running on ball bearings. Possibly 42 inches of yarn under twist.

As made by Messrs. Greenwood & Batley of Leeds the "climax" winding frame contains features specified by them as follows:—

Number of drums per machine as desired. Standard frame: pitch of drums, $7\frac{1}{2}$ inches; length of package, 5 inches; maximum diameter of package, $5\frac{1}{2}$ inches. Supplied without stop-motion if required.

For the winding of up to seven ends of woollen, worsted, cotton, silk, or any other fibrous yarns from spinning bobbins, cops or other forms of supply on to cheeses or cones, 5 inches traverse, or more if required.

Improved stop motion for up to seven ends per drum.

Patent dead-weight disc tension motion ensuring an equal tension on each individual end in winding.

Special breaking-up motion on traverse to avoid "lacing" during winding.

Improved quick-return double-cam traverse motion eliminating overlashing at ends.

Details of Doublers.

For wet work, the spindles may be manufactured on the gravity principle with a loose inner tube, which facilitates the use of an oil cushion, and absorbs any vibration that might result from using unbalanced bobbins, especially at high speeds. For dry-doubling a strong type of spinning spindle may be used, along with a cop-building motion instead of the parallel long lift of the ordinary wet doubler.

For wet work the doubling section of ring is mostly used, having the traveller to clip both upper and lower edges of ring. For dry-doubling the H or spinning section of ring is sometimes used.

Ring-rails for wet-doubling may be specially recessed underneath to clear the traveller and allow ring-grease to be easily cleaned. Rails made in short lengths to facilitate handling when cleaning.

It is optional to use a multiple oil cup base to each spindle in order to facilitate oiling of spindle without taking off the spindle band.

The cop-shape motion may have each bobbin with a sleeve or top let-on fit, while the long lift and parallel bobbin may contain two slits in its base, to fit upon two snugs on the spindle for driving purposes.

Rings are made by highly developed machinery, and may be stamped out of solid steel, afterwards each ring may be turned and

highly polished, and carefully case-hardened. Finally tested for all dimensions before sending away.

Both single and double tin rollers are used for ring-doublers, but perhaps the single tin roller of 8 or 9 inches diameter is mostly preferable, requiring a framing 3 feet 6 inches wide. Tin rollers may be made of heavy gauge tinned steel, accurately balanced, and tested at high speeds.

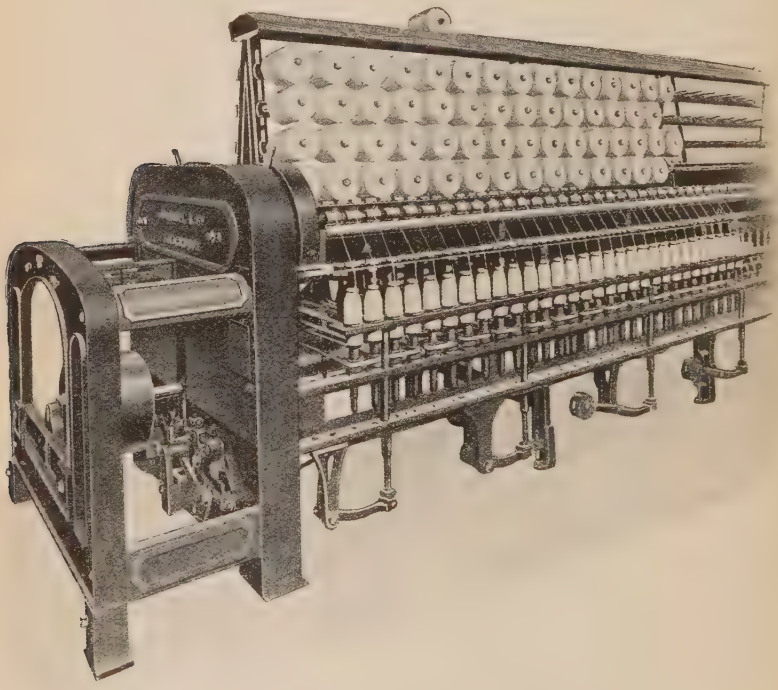

Fig. 84.—Ring-doubler by Messrs. Arundel Ltd.

A general view of a ring-doubler with a 4-height creel is given in Fig. 84.

The *Creel* for ring-doublers may be adapted to various forms of yarn. The more usual modern system is to supply yarn for the doubler or twister on cheeses made at the quick traverse winder, two or more ends wound together; often it may be on double flanged bobbins made at the slow traverse winder. A two-height creel for such work, and more or less fine work, is a common arrangement.

For coarser counts a two or more height of porcupine creel is often used. There has long been more or less demand for creels arranged to take cops or ring-bobbins of single yarn, but this has now been a diminishing feature for many years.

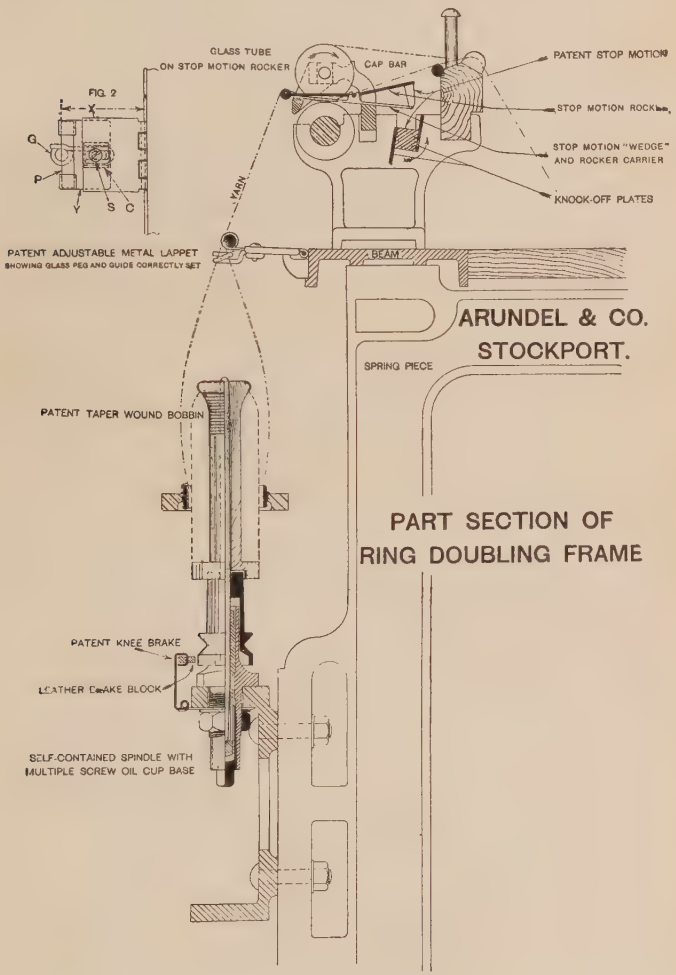

FIG. 85.

In the case of doubling hard twist yarn it is best to apply a yarn traverse motion behind the expression rollers, to prevent the yarn from nicking the rollers.

For some years there has been an increasing tendency towards using patent tapering motions on doubling frames so as to build a bobbin requiring no top flange, although using the full length

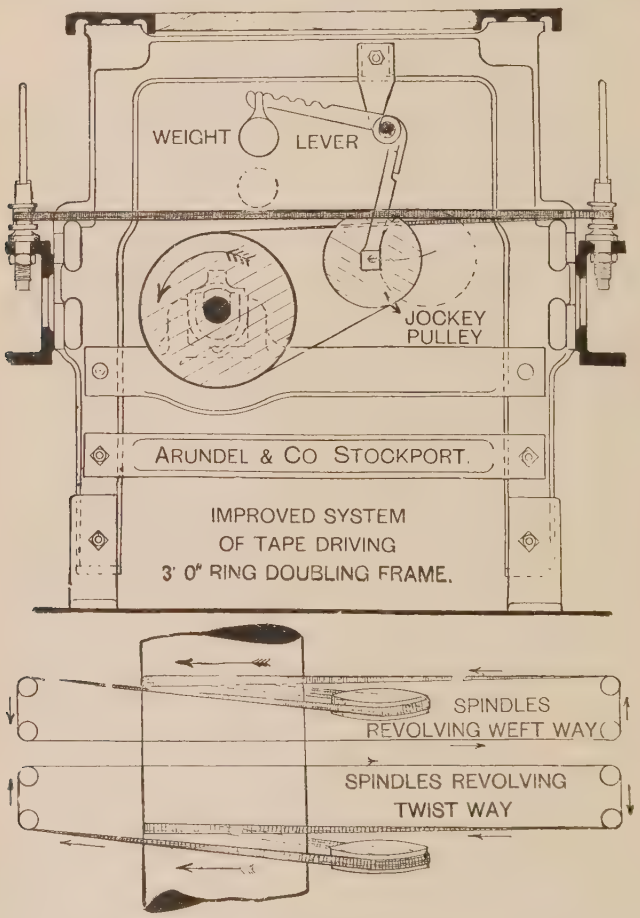

FIG. 86.

parallel lift. Such a bobbin will unwind endways without ravelling since the tapering motion binds the upper coils of yarn very firmly, somewhat on the principle of the bottle bobbins often produced on spindle winding frames, especially for use on gassing frames.

Such bobbins can be doffed at any time without affecting the bobbin shape. Examples are shown earlier in this treatise.

Most correct weights of traveller vary with the spindle speed, diameter of ring, turns per inch in yarn, number of folds, and the class of cotton used for the yarns.

Section Through Ring-doubler (Fig. 85).

This section of Messrs. Arundel's Doubler shows many features of the machine very graphically.

In the small upper left-hand portion is illustrated the method of setting the patent adjustable metal lappet.

The glass carrier slide Y is slotted to enable dimension X to be adjusted until the front edge of the glass stud P is exactly over the spindle centre. The brass guide curl G may then be adjusted until the guide eye is exactly concentric with the spindle, the slide Y and guide G then being clamped in the "set" position by means of the screw and clamp S and C.

The stop-motion illustrated in Fig. 85, has been very successful in diminishing trouble with lashing ends and roller laps.

Messrs. Arundel give the following tables:—

Weight of Yarn on Bobbins.

The weight of yarn contained on bobbin will vary according to amount of twist in the yarn and also the traveller used, but the following figures may be taken as an approximate guide.

1½ in. Ring.	4 in. Lift.	1·3 ozs. of Yarn.
1⅝ in. ,,	4½ in. ,,	1·7 ,, ,,
1⅝ in. ,,	4½ in. ,,	2 ,, ,,
1¾ in. ,,	4½ in. ,,	2·125 ,, ,,
1¾ in. ,,	5 in. ,,	2·25 ,, ,,
2 in. ,,	5 in. ,,	2·5 ,, ,,
2¼ in. ,,	5 in. ,,	4 ,, ,,
2¼ in. ,,	6 in. ,,	4·75 ,, ,,
2½ in. ,,	6 in. ,,	6 ,, ,,
2¾ in. ,,	6 in. ,,	6·5 ,, ,,
3 in. ,,	6 in. ,,	7·25 ,, ,,

Power Required.

70 Sps. per	Horse Power for	1½ in.	dia. Ring.	Sp. Speed	8,500
60 ,,	,, ,,	1¾ in.	,,	,,	8,000
50 ,,	,, ,,	2 in.	,,	,,	7,500
40 ,,	,, ,,	2½ in.	,,	,,	4,500
30 ,,	,, ,,	3 in.	,,	,,	3,750

Tape Drive.

An arrangement of tape driving for spindles by Messrs. Arundel is shown in Fig. 86.

Tape driving for spindles is not new, but is apparently gaining in use at the time of writing. One Bolton firm in particular known to the writer has obtained most excellent results from tape driving during the last two years.

In the arrangement shown in Fig. 86 one tape is used to drive 4 spindles, 2 on each side of the frame. The tape is maintained at uniform tension by the weighted jockey pulley shown. The "climax" winding frame shown at the recent Manchester Exhibition attracted attention to its arrangement of tape driving for spindles.

For the method shown in Fig. 86 advantages may be claimed as stated below, and as compared with ordinary spindle band driving.

(*a*) A more regular drive showing less difference between calculated and actual spindle speeds.

There is consequently less variation in twist.

(*b*) The driving power required for the frame is reduced since spindle drive normally consumes a good proportion of the total horse-power required.

(*c*) There is reduced wear and tear on the spindle wharves.

(*d*) Although it may be greater trouble to apply a tape required for 4 spindles, yet the total labour in banding over a period may be reduced, and there may be considerable reduction in the cost of banding.

Attention to jockey pulleys in oiling and setting, trickiness in applying bands and greater cost of individual tapes may be off-sets.

Twist Calculation (Arundel).

Diameter of tin roller 9 inches.
„ „ spindle wharf $1\frac{1}{8}$ inch.
„ „ bottom roller $1\frac{3}{4}$ inch.
Tin roller wheel 20 teeth.
Bottom twist carrier 90 teeth.
„ twist wheel variable, but taken here at 40 teeth.
Top twist carrier 60 teeth.
Bottom roller wheel 60 teeth.
„ twist carrier 90 teeth.
Top twist wheel variable, but taken here at 30 teeth.

1. From foregoing details find twist per inch.

$$\frac{60 \times 60 \times 90 \times 9}{30 \times 40 \times 20 \times 1\frac{1}{8} \times 1\frac{3}{4} \times \frac{22}{7}} = 19{\cdot}6 \text{ turns per inch.}$$

Distribution of Twist Along the yarn in a Stretch on a Mule or Twiner (Test made by H. Fullard, 16th December, 1922, at Bolton Technical School).

The yarn taken was 2 ends of 20's taken only between the first line of rollers, and approximately 17½ turns per inch put in. Carriage travel 64 ins., roller motion 3½ ins.

The length of draw was divided into 10 parts approximately 6·7 ins. long, and out of each length 6 ins. were tested for twist.

	6·7 Ins.	6·7 Ins.	6·7 Ins.	6·7 Ins.	6·7 Ins.	6·7 Ins.	6·7 Ins.	6·7 Ins.	6·7 Ins.	6·7 Ins.	Turns in 60 Ins.	Average Turns per In.	Coil Twist.	Pure Twist, per In.
Cop No. 1.														
1st Draw	101	99	118	104	97	105	121	110	100	120	1075	17·91	·45	17·46
2nd ,,	106	104	101	104	108	113	113	104	111	110	1074	17·90	·45	17·45
3rd ,,	126	98	113	105	102	103	112	104	111	122	1096	18·26	·45	17·81
4th ,,	115	102	111	109	97	117	97	109	115	103	1075	17·91	·45	17·46
5th ,,	118	99	110	110	110	111	118	104	99	108	1087	18·11	·45	17·66
6th ,,	105	103	117	98	110	119	105	116	108	122	1103	18·38	·45	17·91
7th ,,	101	111	100	100	100	102	109	114	118	128	1083	18·05	·45	17·60
8th ,,	108	100	108	110	93	112	101	109	126	121	1088	18·13	·45	17·68
Average	110	102	110	105	102	110	110	109	111	117	1085	18·08	·45	17·63
Cop No. 2.														
1st Draw	112	96	108	107	103	114	105	121	107	113	1086	18·10	·45	17·65
2nd ,,	117	123	100	102	121	104	97	122	107	98	1091	18·18	·45	17·73
3rd ,,	113	116	111	103	107	106	109	100	112	115	1092	18·20	·45	17·75
4th ,,	106	108	106	103	97	92	104	117	123	115	1071	17·85	·45	17·40
5th ,,	125	103	112	103	102	103	103	110	113	116	1090	18·16	·45	17·71
6th ,,	110	104	118	100	104	111	92	113	114	122	1080	18·13	·45	17·68
7th ,,	100	109	98	110	98	102	119	112	120	112	1080	18·00	·45	17·55
8th ,,	113	110	98	109	94	111	115	103	117	111	1081	18·02	·45	17·57
Average	112	108	106	105	104	106	106	111	114	113	1085	18·08	·45	17·63

Average of 2 cop	111	105	108	105	103	108	108	110	112½	115
	18·5	17·5	18·0	17·5	17·1	18·0	18·0	18·3	18·75	19·1
Diameter	½	7/16	½	5/8	¾	13/16	⅞	15/16	1	⅞
Circum.	1·6	1·4	1·6	2·0	2·4	2·6	2·8	3·0	3·2	2·8
Coil twist	·7	·7	·6	·5	·4	·37	·35	·33	·33	·35
Pure twist	17·9	16·8	17·4	17·0	16·7	17·6	17·6	18·0	18·4	18·8

Average only = 17·2 Average of four divisions = 18·4.

Average 17·62.

The 6·7 ins. nearest to spindle point contains 6·64 per cent. above average.

Second 6·7 ins. from spindle point contains 4·37 per cent. above average.

Third 6·7 ins. from spindle point contains 2·10 per cent. above average.

The 6·7 ins. from rollers contains 1·53 per cent. above average. This is on the spindle blade's next draw.

It is quite customary to use a constant for twist, which is obtained by using all the above data excepting one of the twist wheels. Example: omit the 30 top twist wheel and find the twist constant.

The resultant will then become 590, and this divided by the twist per inch required will give the correct twist wheel, or divided by the wheel will give the twist.

If both top and bottom twist wheels were omitted from the calculation a kind of compound twist wheel would be obtained, and it would be necessary to assume a size for either the top or bottom wheel and then find the remaining one by calculation.

If in the example worked out above the size of bottom twist wheel be altered, then it will be required to calculate a fresh twist constant. Twist calculations are the most common of any on a doubling frame, especially if the long parallel lift is used and not the copping motion.

Mildew.

Mildew in the cotton trade has been defined as "the name given to damage resulting from the growth of a class of low fungi which stain and sometimes cause tender tensile fabrics."

Cotton yarn spinners, and to a much greater extent cotton cloth manufacturers, have greatly suffered at times from mildew damage.

In cases of mildew in yarn or cloth it will usually be found that the material has been in a damp condition, most yarn being damped by conditioning, and much cotton cloth by sizing or dressing, which processes, however, need not cause mildew, if properly done and every care taken in process and subsequently. Exposure to damp still later may develop mildew. The use of flour and starch in the sizing cotton cloth has a tendency to produce mildew under incorrect later conditions. In later transit or storing, sufficient warmth and dryness, with good air circulation, are preventatives of mildew. Preservatives such as fine chloride in the size may help this good work. Mildew is fostered in heavy sizing by the use of such materials as the chlorides of calcium and magnesium in order to facilitate the weighting and yet maintain satisfactory weaving.

Over-drying of lightly sized warp yarn in the slashing frame may weaken the yarn, but on the other hand, leaving the yarn too damp will tend to cause mildew. At 100° to 103° Twaddell it has been suggested to use 4 gallons of chloride of zinc solution to every 280 lb. of starch or flour in order to prevent mildew.

In a case coming to the notice of the present writer occasional dark spots in sized warp yarn were traced to the fact of using a small steam engine to drive the becks and to use the steam from the exhaust to heat the size.

It was found that occasional small drops of cylinder oil went along with the exhaust steam.

In another case of badly sized selvedges it was proved to be due to the admission of cold size at the end or side of the machine sow-box. Good selvedges were always obtained after the first size was arranged to enter the middle of the sow-box.

Knitting.

At the 1922 Manchester Exhibition there was considerable interest taken in a machine placed near the entrance, and which was a kind of cloth knitting loom and making a warp loom fabric, being a cross between the woven cloth and knitted fabric.

The hosiery trade was as strongly represented in the machinery line as the cotton spinning and weaving side.

In the cloth above referred to the cloth had no weft, the warp being knitted.

The development of the hosiery trade has been steady and progressive, many more firms doing this work than formerly. The author has seen a Bolton hosiery-making firm almost every day for nearly 30 years and watched it grow to double, treble, and six times its original size, now employing many hundreds of women as compared with a score or two at first.

Dyeing of Yarn on the Beam.

This is a process which has gained in use during the last few years.

Plant for the purpose is made by Messrs. Baldwin & Heap, whose claims are embodied below.

No doubt the process gains favour because of the great numbers of beams now prepared in spinning mills.

A dyeing-on-the-beam plant complete is contained in a space of 20 feet square, which is not of great first cost and at once effects distinct saving in cost of freightage and labour, saving of time, and increase of output.

Very little labour and skill are needed for using the process.

The yarn on the beam needs no handling during the dyeing process, and it is now claimed that very equal dyeing effects can be produced, especially in some sorts of work.

There is no deterioration in strength and elasticity of the yarn.

Any quantity of yarn may be dyed or bleached by this process, and it is claimed that in one mill alone about 19,000 lb. weight of yarn is being dyed in one day.

Necessary costs include first cost of plant, wages of man who operates the plant, cost of dye, and driving power, steam, and space.

Possible saving features are represented by reduction in trans-

port cost, elimination of certain processes as compared with hank dyeing, saving in time, and also in labour.

Providing proper arrangements are made, proper dye-stuffs obtained and properly used, a spinning or weaving firm may establish a small dyeworks of its own for warp yarns, occupying little space and costing little to operate.

Referring now to the working of the plant. Beams may be from about 250 to 300 lb. each. Taking now beams of 300 lb. each, four of these at once are placed in the creel of the beam dyeing machine. Through the perforations in the beam steam is directed on to the yarn so as to thoroughly open and loosen any oil, particles of leaf, seed, or other impurities.

After sufficient steaming, the steam is turned off and a hydraulic pump set working so as to force water through the yarn until the undesirable matter is washed off, caught in the vat beneath the beams, and carried away through the open drain-cock.

After sufficient washing, the drain-cock is shut and the vat is sufficiently filled with the dyestuff in use, and the dye is forced by the pumping process through the perforations in the beams until the required dyed effect is obtained.

The proper values are then operated, the dyestuff shut off, and all moisture is driven from the yarn by means of an air compressor. Imperfect penetration and distribution of the dye must be avoided.

When the yarn is well dried the beams of yarn are ready for the slashing frame.

Properly carried out, this dyeing of yarn in the beam involves steaming, washing, using the dyestuffs, and drying, but from the male attendant requires only the reasonable amount of skill and labour involved in opening and shutting the various valves and traps when changing from one state to the other, with the beams of yarn remaining in the same position.

It is claimed that uniformity of shade is assured owing to perfect hydrostatic uniformity of distribution. Treble action pumps give a non-pulsating delivery of liquid, and the colour is equally distributed over the full width of beam.

"The beams automatically expand and contract as may be necessary, when the heat of the dye mixture causes an expansion or contraction of the metal."

"One half of the plant is made of cast-iron, and iron perforated beams are used for sulphur colours. The remaining half of the plant is made of an acid-resisting metal throughout, the beams being made of solid copper. The flanges are machined with great precision, and the joints are liquor-proof under all pressures."

The Elton Cop Dyeing Co., of Bury, operate beam dyeing on a somewhat different system from the Baldwin & Heap method, and claim advantages somewhat as below stated:—

1. Cost of beaming or dressing is saved.
2. Dye-house labour cost is very greatly reduced.
3. The preservation of full strength and elasticity in the yarn enables a greater loom production.
4. Reduced cost of dyeing materials.
5. Uneven or streaky dyeings are cancelled and more perfect dyeing is claimed than in the case of chain dyeing. Dyeings may be easily matched.
6. There is a saving in steam and water, and no drying cans or beaming room are required.

(*a*) In this system means are provided for controlling the hardness or density of the beams, and this affects the question of different qualities of yarn acting differently in the same dye-bath. or different dyestuffs acting differently on the same yarns.

The density controlling apparatus can be fitted to any make of warper.

(*b*) By this method the beams are dyed in a vertical position in a closed chamber under greater than atmospheric pressure, and this helps to give satisfactory results.

The air is first removed from the beam in order to impregnate the yarn evenly with dye-liquor.

The vertical position is good for enabling a number of beams to be dyed together, and beams can be raised and lowered in regard to the dyeing chamber very readily by chains and blocks or other mechanical means. It is claimed that a six-beam dyeing chamber can thus be emptied in about 5 minutes.

(*c*) A third principle of this Brandwood or Elton method consists in fixing or developing the colour after dyeing by the application of air pressure from the outside to the inside of the beam.

This air pressure, applied to the outside of the beam, gives a mean effective pressure all through the beam, the whole set of beams are oxidized together at one operation, and all the moisture removed that can be by mechanical means.

The colour is fixed and developed, and most of the moisture removed from all the set of beams together.

It is claimed that the beams may be then allowed to lie in a slashing-room for a few weeks without injury and that there is no need to dry them before slashing.

For this Brandwood system various patents were granted from 1914 forward.

Beam dyeing has been successfully adopted for warps intended for such goods as the following :—

Indigo blue deneme, alpaca linings, chambrays, shirtings, ginghams, awnings, tickings, stripes, and flannelettes.

It is possible that small users of coloured warps will not find

it pay to instal plant for the purpose, but may get the work done elsewhere.

Manufacturers who use a variety of colours and not much

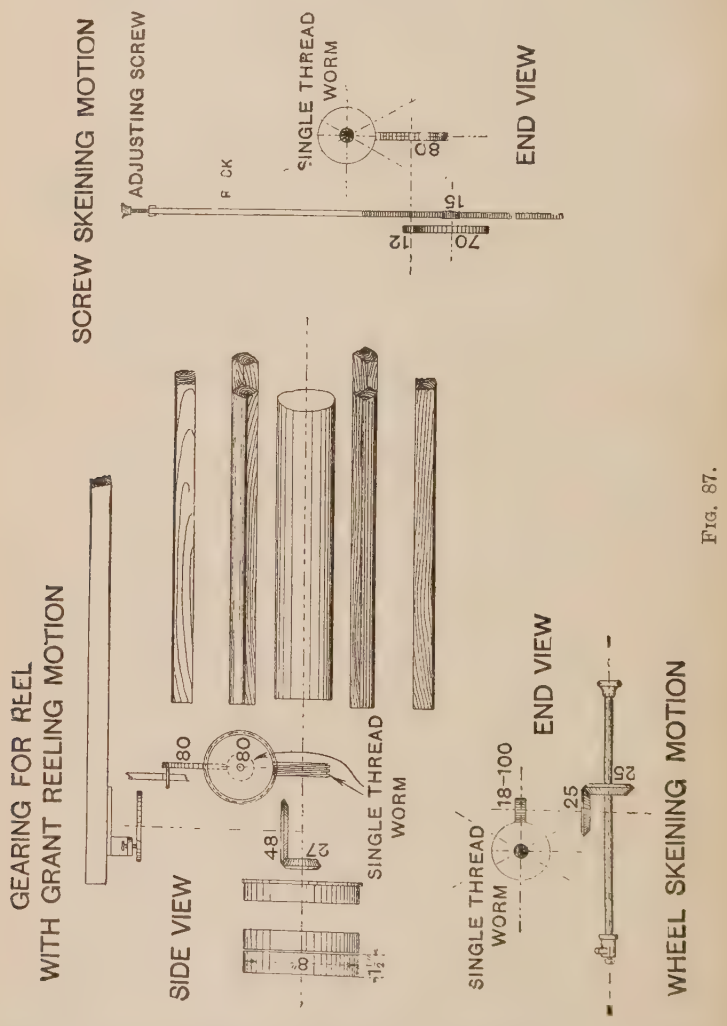

Fig. 87.

weight of any one colour may not find beam dyeing suitable for their work.

Cheese spool dyeing is gaining for these firms, as compared with other methods.

Cheeses or spools can be put behind a slashing frame and run along with beams of grey yarn.

The use of perforated hollow metal skewers for cop dyeing has gradually extended during the last quarter century, and it is possible to force the dye liquor from inside to outside and then outside to inside.

Reeling Grant and Skein.

Grant reeling and skein reeling are two special lines differing from the more stereotyped 7-lea reeling and single hank cross-reeling.

A grant reel attachment, with automatic and adjustable knocking off motion for reeling long lengths up to 8400 yards—equal to 10 single hanks—can be fitted to a reel if desired, and details of Messrs. Arundel's Arrangements are shown in Fig. 87.

The same fig. illustrates their skeining motion. Grant reeling—sometimes known by the name of diamond reeling—implies longer lengths of yarn and wider pitch on the reel so as to get sufficiently open spaces even with the long lengths. The reel can be made to automatically knock off for any length reeled.

Skein reeling is of a totally different character, often requiring shorter than hank lengths of 840 yards, but needing to be of some specified length.

The Fig. shows both a screw and a wheel skeining motion, the latter providing suitable change wheels by which any desired length of skein may be obtained.

Ordinary cross reeling continuously crosses a hank of yarn over the full length of traverse.

Grant reeling does this for longer lengths on an improved method of timing the traverses of the reel circumference. Skein reeling may give a slow continuous traverse to the yarn all one way.

Lea-reeling has the traverse stopped during the reeling of each lea, and then suddenly moves the yarn to a new position.

Vertical Burner Gassing Frame.

A frame made by Messrs. Arundel is shown in Fig. 88, but it will be well understood they make either this or the small bowl passing frame as required.

Referring to Fig. 88, the machine and ventilation are entirely self-contained, and can be fitted in any room without the expense of putting in fans or air ducts. It is simply required to connect the outlet of fan on frame to the open air. One man will mind 160 lights from tape bobbins and 80 lights from cops.

The firm state the essential features of a gassing frame are as quoted below:—

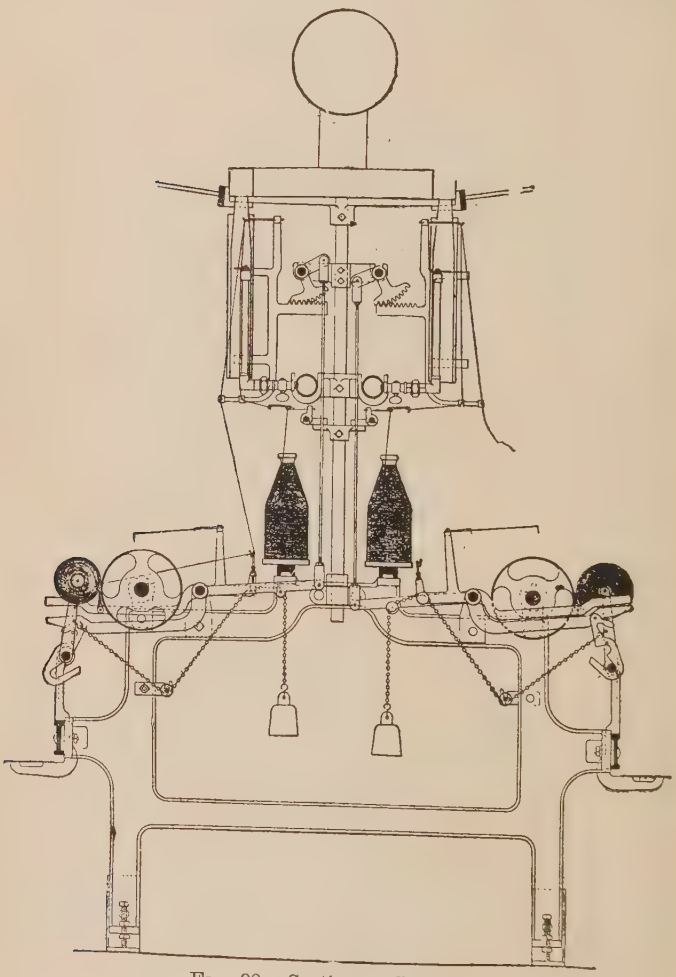

Fig. 88.—Section of Frame.

1. That it should gas any counts perfectly without striping the yarn or varying in any degree.
2. Economy of gas.
3. Economy of waste.

4. Perfect ventilation in each burner, this benefiting the comfort and health of the attendant.

5. Ease of attention.

6. Speed.

It is claimed for the frame shown "that perfect gassing is insured by the guide for the yarn being part and parcel of the burner itself. The movement for guiding the yarn in and out of the flame is separate from the actual guides. The yarn is always kept in the centre of the flame and at a certain fixed distance from it. The burner itself is a series of holes in a vertical tube, and owing to its position it avoids all chance of the holes becoming blocked up by fluff or dirt. So with keeping the mixture of gas and air constant, the holes in the burner always the same size, the yarn always in the centre of the flame, the flame guarded from any draught of air by special hoods, the gassing of the yarn is insured to be constant." Burner of 18 holes.

Yarn may be passed twice through flame for coarse counts. Six or 12 holes can be shut off if desired. It is possible to maintain a constant pressure on the burners and to use the very weakest mixture at which the gas will light.

The split drum is provided with a pick-up device to guide the threads into the slit, and there is a tension regulator which throws out of the drum the restraining length of yarn when an end breaks.

The Gas.—Coal gas from the town's mains is generally obtainable for gas singeing of yarn—at any rate in this country.

Where this is not the case it is possible to make the gas, and the "Mansfield" oil gas apparatus has been recommended. Messrs. Arundel say: "This is a simple process by means of which gas, suitable for gassing yarns, can be made from paraffin oil, kerosene, palm oil, cocoa-nut oil, olive oil, mutton fat, or any other form of oil or grease."

The complete plant consists of a "producer" which makes the gas and a gas-holder which stores it. The producer is fixed in a small outhouse or shed, or any existing building where space is available. The gas-holder is placed outside, as it requires no protection from the weather."

"The process of manufacture consists of pouring the oil or grease in a fine stream, into a red-hot retort, where it is immediately converted into gas, which is conducted through pipes into the gas holder for storing and use as required."

"Gas made by Mansfield's oil-gas apparatus is not a vapour, but a fixed gas, which will not condense and cannot be converted into oil again. The retort is heated either with wood or coal."

Another one of various methods is the "Alpha" gas-making machine, which produces a gas from gasolene, a spirit of petroleum, and very good results are obtained from it.

Automatic Knot Tying.

For quite a number of years now the Barber knotter has been an accepted, successful, and much used device.

It is a tribute to its success that three or four different firms were showing hand knotters on the same general lines as the Barber, but with sufficiently distinct differences in detail.

Barber and Colman of course manufacture the well-known warp-tying machine, and the warp-drawing-in machine as well as the smaller but equally well-known Barber knotter. It is scarcely necessary nowadays to enlarge on the value of quickly making reliable neat and small knots at winding frames and other machines. The value of such excellent knots at the loom in the warps is inestimable.

At the Manchester Exhibition, Barber and Colman not only showed their well-established knotter but also a comparatively new and smaller one termed the simplex knotter.

It is stated that the simplex does not release the yarn at the bottom of the thumb piece stroke. The thumb piece is allowed to return to its upward or operating position.

The simplex knotter is smaller and cheaper than the older Barber knotter, and is very simply constructed while yet appearing to be strong and durable. Demonstrations were made to show the fewness of the parts of the "simplex" knotter and the ease with which it could be pulled to pieces and reconstructed.

Driving Shafts.

Electric driving has enormously increased in use of recent years for Doubling Mills. On the ring or flyer doublers themselves it is quite convenient to directly couple a motor to the tin roller shaft so as to utilise individual driving. Driving two more machines from a top shaft driven by motor offers economy in motor seize and greater convenience in changing speeds of tin rollers.

For line shaft driving about 250 r.p.m. of line shaft is suitable for quick traverse winders using $\frac{1}{2}$ twisted belts. One line of shafting may drive two rows of doubling frames by means of gallows pulleys, at line shaft speeds of 280 to 340; line shafts for reels 200 to 250 by $\frac{1}{2}$ crossed belt; much the same for clearing frames and gassing frames.

Doubling Mill Plan: 25,200 *Doubling Spindles with the other Proportionate Machinery* (*Messrs. Arundel*).

Shed buildings are best for doubling mills, as in the case of weaving sheds, although not always found in practice.

Fig. 89 is a good example.

A shed building is best for handling the material and also for supervision.

Plan of Ring Doubling Mill Containing 25,200 *Doubling Spindles* (Fig. 89). (Arundel.)

Specification of Machinery on Plan.

16	Patent Quick Traverse Winding Frames .	142 Drums,	7-inch Gauge,	5-inch Traverse.	
50	Ring Doubling Frames . .	440 Spindles,	$2\frac{1}{2}$-inch ,,	$1\frac{3}{4}$-inch Ring.	
8	Ring Doubling Frames . .	400 ,,	$2\frac{3}{4}$-inch ,,	2-inch ,,	
6	Upright Spindle Clearing Frames . .	444 ,,	5-inch ,,	8-inch Lift.	
4	Patent Vertical Burner High Speed Gassing Frames . .	150 Light	6-inch ,,	3-inch Traverse.	
1	Patent Gas and Air Mixing Machine.				
18	Double 40-Hank Bobbin Reels.				
8	Patent Yarn Preparing Machines.				
2	Bundling Presses.				

A good clay subsoil offers a solid foundation for a mill. Period 1920-22, much trouble was caused for a mill in the Bolton District by finding quicksands on a site purchased for mill building.

It is advisable in projecting a new doubling concern that such features as the following shall be well known to all concerned.

(*a*) Number of doubling spindles proposed, or weight, counts and folds of yarn expected. In particular must it be made clear the proportion of yarn to be gassed (if any) and the proportion for use "plain."

(*b*) The type of building and rooms to be used, with dimensions, and whether shed or storey building.

(*c*) The character of the drive, whether steam, electrical, or gas, and if electrical drive it must be stated how the electric current will be obtained.

(*d*) A supply of good, clean water in sufficient and regular amount is required.

(*e*) It must soon be determined in what form and proportions the yarn will be marketed; as, for example, in cheeses, pirns, cones, beams, reeled hanks, or any other way.

Beaming from Cheeses.

It is the writer's experience that making beam warps from quick traverse cheeses of yarn in the Vee creel of the warper, is likely to give more trouble than making beam warps from the ordinary flanged warper's bobbins, built up on a slow traverse winding frame. The large crossings of yarn and the small number

of coils or wraps of yarn per width of cheese, have a tendency to pull the yarn from the quick traverse cheeses in a very irregular and unsteady manner. This is all against the regular and steady yarn tension that is required for good work and for the correct operation of drop wires.

Changing from Weft-way to Twist-way.

In making this kind of changing from twist to weft-way at any machine there will be trouble unless skill and care are exercised.

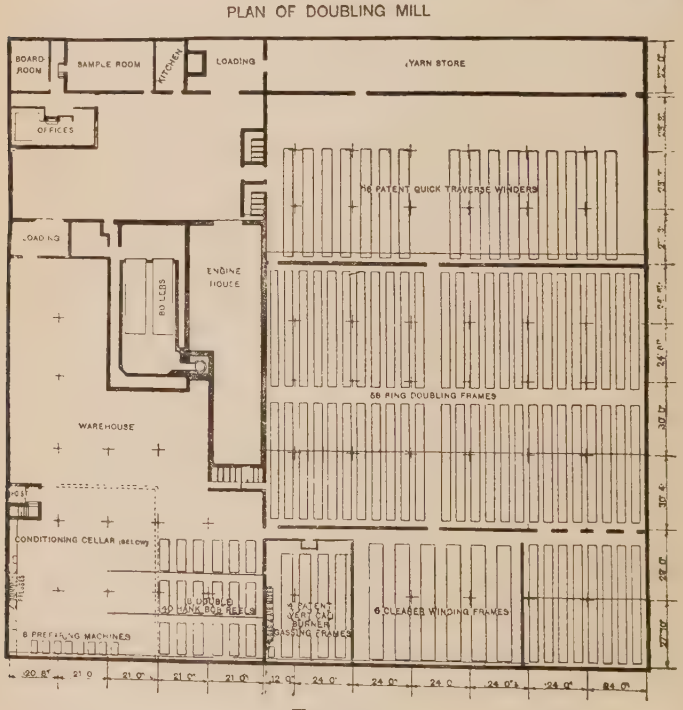

FIG. 89.

Even when doing this on the spinning mule it it is necessary to wind on the bare spindle a cop of the twist direction it is intended to produce and not of the sort that is being discarded. The same kind of effect must be noted when changing at other machines. and at the warping machine or loom it may give trouble when changing from single-yarn to two-fold, or vice-versa. In a case

of twisting a strong, hard-twisted single yarn to a soft-twisted two-fold, satisfactory piecings were effected by twisting in the opposite direction from the hard twisted single.

Artificial Silk. Celanese.

One of the more recent developments in the way of artificial silk bears the name of "Celanese," and is manufactured from cellulose acetate by the British Cellulose and Chemical Manufacturing Co., for whom, at their Derby works, one of the writer's former students, Mr. Catlow, has been working for some time. At the time of writing, celanese is in great demand both for knitted and woven fabrics.

A good deal of work has been found for dyeing chemists and colourists in searching for dyestuffs which have a direct affinity for the new yarn. Dyestuffs have been arranged into (*a*) those which leave the celanese part white when dyeing fabrics of mixed materials, and (*b*) those dyestuffs which do not leave the celanese white.

This feature of celanese offers excellent prospects for the production of novelty effects, as the resist effects with grey cotton yarns have not previously been satisfactory with other forms of artificial silk and not always so with real silk.

Much business has been done done with "celanese" in connection with producing flowered and fancy effects with celanese woven on coloured cotton warps.

Hosiery manufacturers are already very practically interested in celanese. Artificial silk hosiery has often been somewhat flimsy, but with the special dyeing effects possible in mixed goods of celanese and cotton there may be a good foundation of cotton yarn, combined with the bright effect of artificial silk or celanese knit together in any proportions desired. Novelty effects are readily obtained in this manner, and at a moderate cost celanese has been doubled with grey cotton yarns of any counts and twists desired and knitted into underwear, ties, and scarves.

Lace and Embroidery Trades.

In spite of the fact that England produces the finest cotton yarns in existence—and to any extent required—the lace and embroidery trades have been in a languishing condition.

Late in January, 1923, a mass meeting in Nottingham, fully representative of these trades, decided to make a strong application to the Prime Minister, seeking for the protection of the British lace and embroidery trades by the application to those trades of the Safeguarding of Industries Act. It is sought to have a duty of

33⅓ per cent. imposed upon French and other foreign laces and embroideries, that are freely imported into this country at present.

Imports from Calais and other Gallic centres favoured by

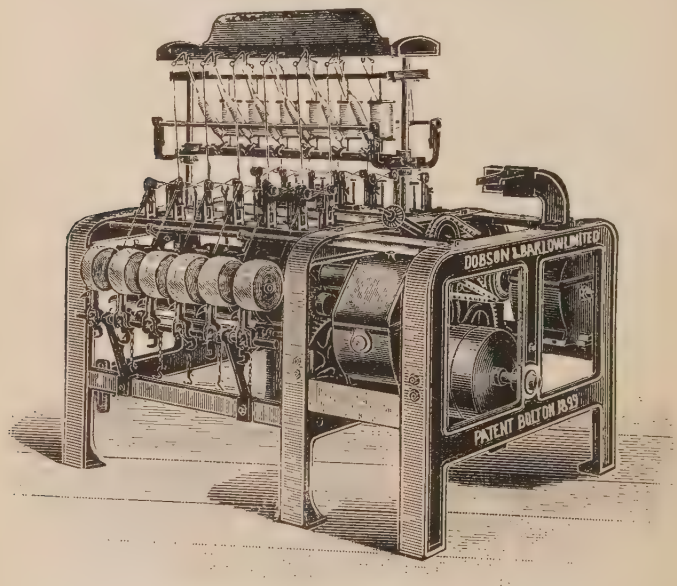

FIG. 90.—Gassing Frame.

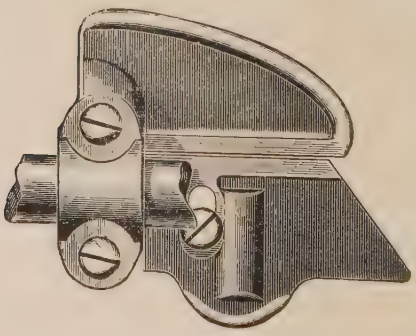

FIG. 91.—Metal Yarn Clearer.

Exchange rates are rapidly helping to kill British production in lace and embroidery.

The curtain and plain net branches of the trade were not so

much involved as were fabrics made on levers frames, representing lace generally for adornment, millinery, dressmaking, and other decorative purposes.

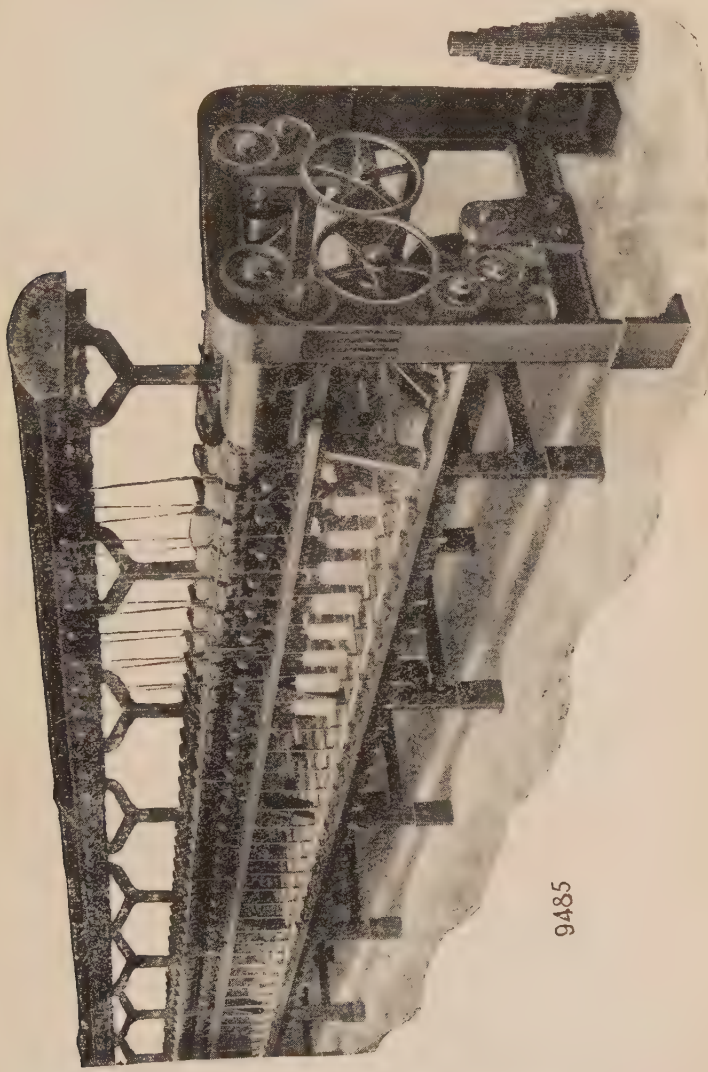

Fig. 92.—Climax Twister and Winder. (See page 365).

Period 1922-3 much valuable lace machinery in Nottingham was rusting for want of use, and operatives were in a bad way.

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